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## Editorial

### FUNDAMENTALS OF HERNIOPLASTY

THE surgical literature of the past two decades has offered many articles about inguinal hernias. There have been reported careful dissections of the inguinal regions with newer concepts of old anatomical details. Numerous modifications of old methods of repair have been offered and new technics suggested. In so many of these discussions, the basic details of hernia repair have been hastily passed over or not mentioned at all. These fundamental details which were described by the surgeons of the preceding generation, still remain the bulwark of satisfactory hernia repair. For the younger surgeon, who perhaps is a little confused by the great volume of writings, a careful study of these details is urged, for it is only in light of them that any of the newer procedures should be considered.

The first principle is to make an adequate incision. So often we see the surgeon attempting to work through a small incision—almost a button hole—as if the size of the final scar was important. A generous incision, four to five inches in length is essential if satisfactory repair is to follow. It should commence well above the location of the internal abdominal ring and be carried down to the external or subcutaneous ring. The location of this incision is important, too. If it is placed low, there remains insufficient of the

aponeurosis of the external oblique to suture easily; if it is too far above the canal, the problem of dealing with the internal oblique or the falx may be difficult. Usually the most satisfactory location is one inch above and parallel to the inguinal ligament. In operating upon strangulated or incarcerated hernias, so often these facts are overlooked and the incision is made over the bulging area, thereby causing difficulty of repair.

Adequate exposure and wide dissection of layers with careful identification of all structures is likewise very important. This can be accomplished only by slow and painstaking work. Tissues must be treated with respect if we wish them to heal kindly and with the minimum of reaction. Forceful tearing, application of powerful clamps and unnecessary handling of tissues must all be avoided. Dissection of the various layers must be carried out widely enough so that approximation can later be done without tension.

Complete hemostasis is most important. Even the smallest of bleeders should be controlled by ties for the accumulation of serum in the wound predisposes to tension and is an excellent medium for bacterial growth. Particular attention to this detail, when using spinal anesthesia, is required; for with the lowered blood pressure many small vessels cease bleeding temporarily,

only to open up again when the pressure rises.

Careful and high dissection of the sac is also a fundamental. Extraperitoneal fat should be carefully removed from the neck so that closure is secure. The bladder may have to be freed from the sac. Intraperitoneal attachments of intestine or omenta must be liberated. Hesselbach's triangle should be explored with the finger from within to make sure that there is not another peritoneal pocket in this area as so frequently occurs. To leave such a pouch means almost certain recurrence. A maneuver which facilitates disposal of this extra sac is to pull it through beneath the inferior (deep) epigastric vessels, thereby converting the two sacs into one large one. Twisting of the sac makes high ligation simple; in other instances, the sac may have to be trimmed off as high as possible and closed with a running suture.

The surgeon should be familiar with the basic details of the several types of repair. He should reserve the Coley-Ferguson procedure for children or for adults in whom it is necessary to maintain the length of the cord if there is incomplete descent of the testis also present. He should realize that the modified Bassini technic is indicated only for simple hernias and when structures approach the normal. He must appreciate that for all recurrent or difficult hernias, the Halsted method with subcutaneous transplantation of the cord, is the most satisfactory. Likewise he should be familiar with the variants of these operations and especially the imbrication modi-

fications. Lastly, he should be capable of utilizing fascial transplants or fascial sutures if needed. Hernia repairs are not easy; they are not operations to be delegated to the interne; they require the maximum of knowledge and judgment.

When it comes to the use of suture material, I do not believe that the kind of material used is important. What is important is the size of the material used and the tension under which it is applied. If one prefers catgut, by all means use catgut, for it is hard for the catgut surgeon to change to silk or cotton and achieve good results. However, there is no justification for the use of large sized catgut which permits tissues to be pulled together under tension. The purpose of a suture is to hold tissues in approximation until they heal. If it is under tension, the suture either cuts through the tissues or causes pressure necrosis either of which defeats the purpose. Fine catgut, on the other hand, will stand only the minimal strain and so its use is predicated upon adequate dissection with resulting lack of tension; the proper use of fine catgut allows healing to progress in the desired fashion. The same results may be achieved by the use of fine silk or cotton and these materials produced much less tissue reaction.

Careful attention to these fundamentals will enable the surgeon to repair the great number of hernias successfully; newer and less tried procedures may well be reserved for the exceptional cases.

ARTHUR M. DICKINSON, M.D.



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# Original Articles

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## GENITAL FISTULAS IN WOMEN\*

### THE LIFE OF J. MARION SIMS AND THE HISTORY OF VESICOVAGINAL FISTULA— MANAGEMENT OF RECTOVAGINAL FISTULAS AND COMPLETE TEARS OF THE PERINEUM

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THE history of medicine, to which the medical student turns for inspiration, and the busy physician for solace and comfort, contains the names of many illustrious Americans who, because of their untiring efforts and genius, have added to the cause of the cure of disease and have thereby benefited mankind. Some of these men worked in the laboratory, in the field of pure scientific research, whereas others as practitioners of medicine applied the fruits of this research to allay human suffering and save human lives, and still others devised surgical procedures with the same end in view.

The first portion of this article deals with the life of J. Marion Sims, who was such a great American physician. The history of his life shows how what appear

to be insurmountable obstacles may be overcome. The story of the development of his operation for the cure of vesicovaginal fistula, one of the most distressing maladies affecting womankind, stands out as an epic of American medicine. The second part deals with the management of rectovaginal fistulas and complete tears of the perineum, the two conditions being closely associated since the former is frequently the result of improper healing of the latter. The name of no single eminent surgeon is connected with this second lesion. However, the names of a number of surgeons who have worked patiently and diligently stand out. Each one of them has added something to the sum total of practical knowledge necessary to make its surgical repair successful.

#### NOTES ON THE LIFE OF J. MARION SIMS AND ON THE STORY OF VESICOVAGINAL FISTULA

J. Marion Sims was born ten miles south of the village of Lancaster, Lancaster county, South Carolina, on January 25, 1813.<sup>2</sup> The ancestors of his father, John Sims, were of the English colonists of Virginia. His mother, Mahala Mackey, was of Scotch-Irish origin.

Sims graduated from Columbia College, South Carolina, in 1832. In February, 1833, he began to read medicine with Dr.

Churchill Jones, of his home town, to the great disappointment of his father, who wanted him to study law. He arrived in Charleston on November 12th of that year and began to study medicine at the Charleston Medical College, registering for a term of lectures. The term concluded at the end of February, 1834, and Sims returned to Lancaster and resumed his studies with Dr. Jones. The last of the

\* The Charles Sumner Bacon Lectures for 1943-1944, University of Illinois, College of Medicine, Chicago, December 1 and 2, 1943. From the Department of Gynecology, Tufts College Medical School, and the Department of Obstetrics and Gynecology, Carney Hospital, Boston, Massachusetts.



following September he went to Philadelphia, to continue his studies at the Jefferson Medical College, and travel being by

He returned to Lancaster, South Carolina, in May, 1835, and opened an office on Main Street for the practice of medicine.



FIG. 1. J. Marion Sims, 1813-1883.

stage it took a week to make the journey. While at Jefferson, Professor McClellan, a great surgeon of his day and the founder of Jefferson Medical College, made a lasting impression on Sims, since he had been privileged to assist him in some of his surgical operations. Sims graduated in March, 1835, but remained in Philadelphia for a month's course of lectures on regional anatomy and surgical anatomy by Professor Patterson, head of the Department of Anatomy at that institution. As he stated, "When I graduated I presume I could have gone into the dissecting room and cut down upon any artery and put a ligature around it, but I knew nothing at all about the practice of medicine."

His first two patients were children, and both died of cholera infantum. His third patient, whom he treated for delirium tremens, recovered. This patient was the richest man of the town and gave Sims a ten-dollar bill for his efforts.

It took three weeks to go from Lancaster to Mount Meigs, Montgomery County, Alabama, where Sims again started in practice in November, 1835, buying the practice of Dr. Childers for two hundred dollars. In 1837, he accepted a partnership with Dr. Blakey, a planter on a large scale, who wanted to give up part of his practice with the influential people in Macon County, near Cubahatchee Creek. Dr. Blakey at once introduced Sims to a large practice in the Abercrombie neighbor-

hood, and soon he had all he could possibly do. He had been married to Theresa Jones of Lancaster by his college classmate, the

gated the literature of the subject "thoroughly and fully." The next day he met Mr. Westcott and explained to him that

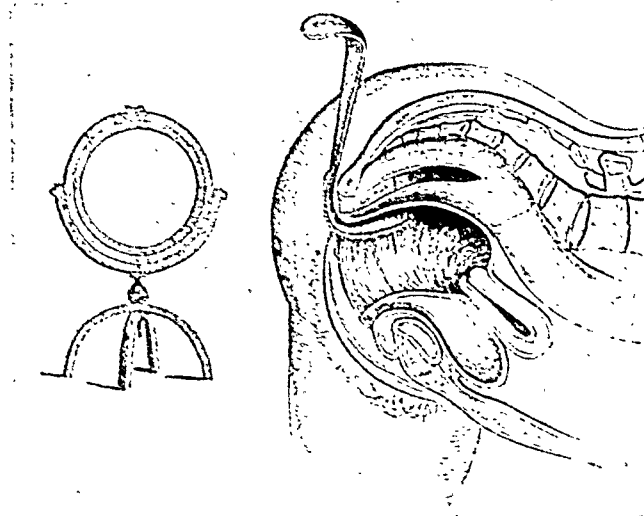


FIG. 2. A mirror eight or ten inches in diameter with which rays of light were directed into the vagina over the surface of the speculum to be reflected on the anterior vaginal wall.

Reverend Mr. Thornwall, in December, 1836. He prospered, but because of intermittent fever, which afflicted him and his family severely, he decided, after consultation with his wife, to establish himself in Montgomery, where he arrived on December 13, 1840. He always considered the thirteenth his lucky day or his lucky number. By June, 1845, Sims had been a doctor about ten years. He was then sent by Dr. Henry, of Montgomery, to the home of Mr. Westcott, whose colored servant, Anarcha, had been in labor three days, with the child not yet born. Dr. Henry and Sims found a well developed young woman, seventeen years of age. The child's head was impacted in the pelvis and labor pains had almost completely ceased. The patient was delivered by forceps with no great effort. Five days later Dr. Henry reported that there was extensive sloughing of the soft parts and that the mother had lost control of her bladder and rectum. Sims went to see her and found enormous sloughs from the posterior and anterior vaginal walls. As he wrote, "This case was hopelessly incurable." He went home and investi-

Anarcha had an affliction that unfitted her to perform the duties required of a servant, that she would not die, but that she must be taken care of as long as she lived. This was agreed to by Mr. Westcott. Anarcha's vesicovaginal fistula was the first that Sims had seen.

One month later, Dr. Harris from Lowndes County sent him Betsey, a girl seventeen or eighteen years of age, who had had a baby one month previously. Examination showed that the base of the bladder had been destroyed, and Sims pronounced her case incurable. Still another month later, or two months after Sims had seen Anarcha, Mr. Tom Zimmerman of Macon County sent him his slave girl, Lucy, about eighteen years of age, who had given birth to a child two months previously and was unable to hold her water. At that time Sims had a little hospital consisting of eight beds in the corner of his yard for taking care of his Negro patients and for Negro surgical cases; so when Lucy arrived by train he gave her a bed there. After a minute examination he told her that there was no hope, that she could not be cured,

and that she must go home on the next afternoon.

The following morning Sims was sent

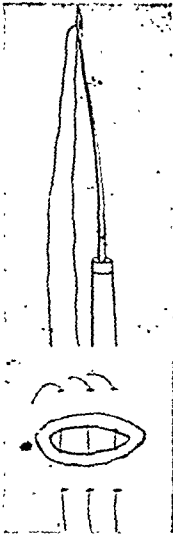


FIG. 3. Push needle employed by Sims and the introduction of the sutures about the fistula.

for to see a Mrs. Merrill, who had been thrown from her pony. She was an obese woman, weighing two hundred pounds; she was in bed with great pain, which Sims ascribed to an acute retroversion of the uterus. He placed her in the knee-chest position and introduced two fingers into the vagina; the vagina ballooned with air, so that he could not feel its walls, but he was able to push the uterus into the forward position, and when she assumed the reclining position her pain stopped. He had been told in class by one of his teachers at the Charleston Medical College, Dr. Prioleau, of the use of the genupectoral position in the reduction of a sudden version, but up to the time of seeing Mrs. Merrill he had not used it and had forgotten about it. When this patient again assumed the reclining position there was an escape of air through the vagina, accompanied by noise. This inspired Sims with the idea that if the vagina distended with air in a woman in the knee-chest

position, by taking advantage of this he might be better able to examine a vesicovaginal fistula and its relations. Giving up the calls that he had to make on twenty patients that morning, he drove home, stopping at a store on the way and buying a pewter spoon. Arriving at his office, where he had two medical students as his assistants, Sims said, "Come, boys, go to the hospital with me." When he got there he told Lucy that he wanted to make one more examination before sending her home. On a table three feet long, upon which was spread a coverlet, he placed her on her knees, with her head resting on the palms of her hands. The students stood on each side of the pelvis. "They laid hold of the nates and pulled them open." Sims writes, "Before I could get the bent spoon handle into the vagina, the air rushed in with a puffing noise, dilating the vagina to its fullest extent. Introducing the bent handle of the spoon, I saw everything as no man had ever seen before. The fistula was as plain as the nose on a man's face. The edges were clear and well defined, and distinct, and the opening could be measured as if it had been cut out of a piece of plain paper. The walls of the vagina could be seen closing in every direction. The neck of the uterus was distinct and even the secretions from the neck could be seen as a tear glistening in the eye, clear, even and distinct, and as plain as could be." He asked himself why these conditions could not be cured. "It seems to me that there is nothing to do but to pare the edges of the fistula and bring it together nicely, introduce a catheter in the neck of the bladder and drain the urine off continually, and the case will be cured." The more he thought of it the more Sims was convinced that he was on the eve of one of the greatest discoveries of the day. He did not send Lucy home, but went to work to invent instruments. The speculum or retractor was clear from the start—the bent spoon.

He sent for Anarcha and Betsey, and he ransacked the country for cases and found six or seven cases of vesicovaginal fistula that had been hidden away for years in the country because they had been pronounced incurable. He added another story to his hospital, which gave him sixteen beds, twelve for patients and four for servants. He then made this proposition to the owners of Anarcha and Betsey: "If you will give me Anarcha and Betsey for experiment, I agree to perform no experiment or operation on either of them to endanger their lives, and will not charge a cent for keeping them, but you must pay their taxes and clothe them. I will keep them at my own expense." In his enthusiasm, he had expected to cure them in six months, so well had he visualized the details of the operation.

It took three months to have the instruments made, to bring in the patients, and to have everything in readiness for operation. The first patient Sims operated on was Lucy, this operation being performed in December, 1845. Her case was a bad one, there being an opening two inches in diameter at the base of the bladder. She was operated on in the knee-chest position, without anesthesia, the operation taking about an hour and being performed in the presence of twelve doctors. Since Würtzer of Germany, in an attempt to cure a fistula, had been unable to keep a catheter in the bladder, Sims introduced a piece of sponge into the neck of the bladder, with a silk string running through it, to draw out the urine by capillary attraction and thus keep the bladder empty. In five days Lucy was very sick; she had a high fever and pulse and signs of blood poisoning. All sutures were cut and removed and there was great difficulty in removing the sponge, which had become incrustrated with urinary salts. The bladder was irrigated and although Lucy was sick enough to die, she rapidly recovered and was well in ten days. After recovery she was examined; the enormous fistula

had disappeared, and only two small openings in the line of union across the vagina remained. The problem, therefore,

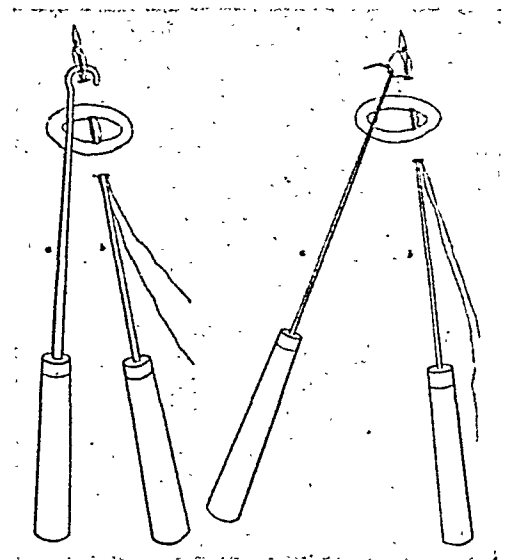


FIG. 4. The technic of introducing the sutures.

was to find something that would draw the urine but would not result in inflammation of the soft parts.

The second patient operated upon was Betsey, who also had a large fistula at the base of the bladder, about two inches in diameter. The operation followed the same technic employed in Lucy's case but a self-retaining catheter was substituted for the sponge. At the end of seven days there had been no chills and fever and the sutures were removed. The operation was a failure but the opening had changed in character. The line of union was in a transverse direction; the fistula was united except for three small openings, one in the center and one at each end.

The third patient to be operated upon was Anarcha. In addition to a large vesicovaginal fistula involving the base of the bladder, she also had a rectovaginal fistula, and, because of the irritation, the external parts had the appearance of confluent small pox. Her condition was pitiful, and, as Sims stated, "Death would have been preferable, but patients of this kind never die; they must live and suffer." Like the two previous cases,

there was imperfect healing, and two or three small openings remained in the line of union.

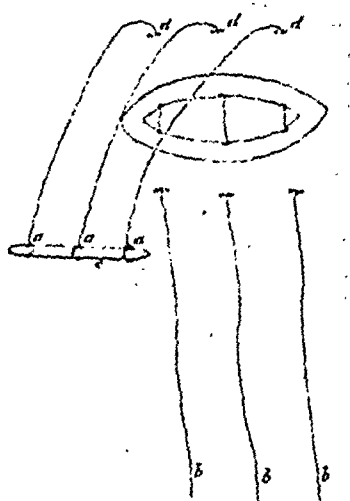


FIG. 5. The placing of the silver wire sutures.

In addition to Lucy, Betsey and Anarcha, Sims had three or four more patients to operate upon, and there was no time when he could not have a subject for operation; but all his operations, so far as a positive cure was concerned, failed. He kept all of these Negroes at his own expense, a considerable task for a young country doctor. With three years of constant failure, the other doctors in the city, who at first were interested and willing to help, became discouraged, and Sims could not get a colleague to help him. Finally, he had to perform these operations with the help of the patients themselves. At this time his brother-in-law, Dr. Rush Jones, advised him to give up his experiments and to devote his life to his practice and to the care of his growing family.

One year after his conversation with Dr. Jones, Sims evolved the method of tying the sutures high in the vagina, where it was difficult to reach, by drawing the ends through a perforated lead shot which was crushed. This method was tried on Lucy. After a month of anxious waiting, examination showed a complete failure. In reasoning out the cause of this failure

following his greatly improved technic, Sims came to the conclusion that it might be the suture material that was at

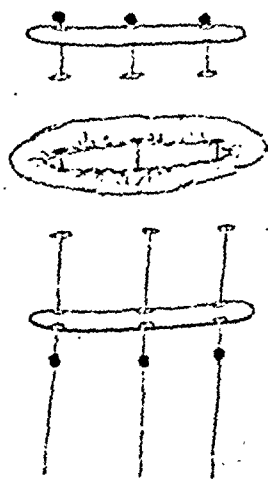


FIG. 6. Silver wire sutures passed through two clamps, one on each side; the fistula ready for closing.

fault. He was looking for a substitute for silk thread. Meltor, of Virginia, had used lead, and Sims had used a lead suture and had failed. "Just in this time of tribulation about the subject, I was walking from my house to the office and picked up a little piece of brass wire in the yard. It was very fine, and such as was used formerly as springs in suspenders before the days of India rubber. I took it around to Mr. Swan, who was then my jeweler, and asked him if he could make me a little silver wire about the size of the piece of brass wire. He said yes, and he made it, he made it of all pure silver."

Anarcha was the patient whose fistula was sutured with silver wire for the experiment. Her fistula, at the base of the bladder, now admitted the tip of the little finger. The edges of the wound were denuded and brought together with four of these fine silver-wire sutures, passed through narrow strips of lead on each side of the fistula, and tightened by crushed perforated lead shots. *This was the thirtieth operation performed on Anarcha.* She was put to bed, a catheter was intro-

duced, and the next day "the urine came from the bladder as clear and as limpid as spring water and so it continued during

as a result of diarrhea, and took his family to Butler Springs. Getting progressively weaker, and seeing no improvement

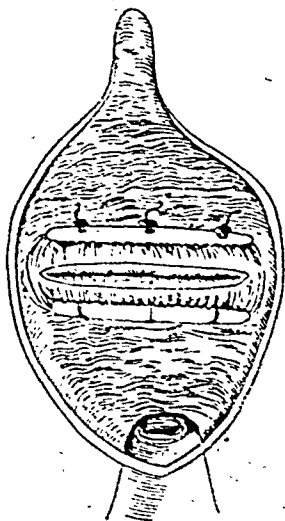


FIG. 7. Edges of the fistula approximated by means of two clamps and held in place by perforated lead shots. (Figures 2 to 7 through the courtesy of *Ciba Symposia*, 5: 1509-1513, 1943.)

all the time she wore the catheter." Previously, when silk was used there was cystitis and edema of the urethra and the urine was loaded with a thick, ropy mucus. With silver wire all these were absent. At the end of a week Anarcha was taken from her bed to the operating table. She was placed in the lateral prone position and the speculum was introduced, "and there lay the suture apparatus, just exactly as I had placed it, there was no inflammation, there was no tumefaction, nothing unnatural, and a very perfect union of the little fistula."

This had taken place in May or June, 1849, after four years of experimenting and discouragement. Thus was born the operation for vesicovaginal fistula. In the course of the two weeks that followed both Lucy and Betsey were treated by the same method, without any greater discomfort, and were also cured. Sims then realized that he had made one of the most important discoveries of the age for the relief of suffering humanity.

Six weeks after his success he collapsed



FIG. 8. The Monument dedicated to J. Marion Sims. George Gray Ward. *Bull. New York Acad. Med.*, 10: 722-724, 1934.

through July, August and September, he went north to New York for a change of climate, returning to Montgomery in October, 1849, and gradually grew worse, the diarrhea being uncontrolled. There followed trips to Cooper's Well for the water cure, to New Orleans and again to New York, with remissions and recurrences of the disease. Sims was unable to work and at last took to his bed believing that he was to die. While in bed he wrote the history of his operation for vesicovaginal fistula. This was published in January, 1852, in the *American Journal of Medical Sciences*.<sup>1</sup>

Because the climate of New York seemed to agree with him better than that of Montgomery, Sims sold his house and a partnership in a drug store in Montgomery and left for New York in May, 1853, so near death that no one thought he would reach his destination alive. He had gone to New York for the sole purpose of prolonging his life as he felt better there than anywhere else. With his limited funds he had great financial difficulties. The leading

New York surgeons, having been taught his operation for vesicovaginal fistula and that on the ruptured perineum by him,

hospital was organized in the home of a Mrs. Codwise on February 10, 1855. Two prominent New York physicians called on

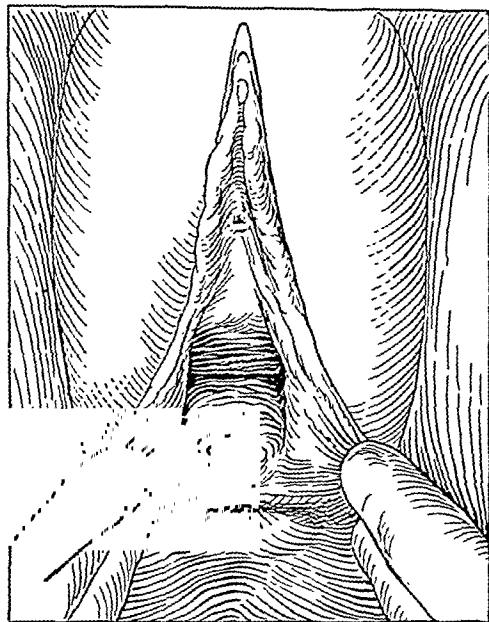


FIG. 9. Complete laceration of the perineum.

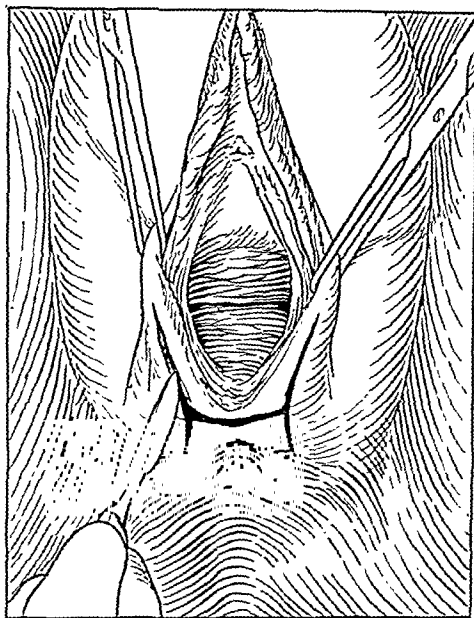


FIG. 10. Incision. The incision takes the form of a capital H. The lateral incision on each side extends from a point below the duct of the vulvovaginal gland to the retracted end of the sphincter. The transverse incision joins the two lateral incisions by running through the scar tissue uniting the rectal and vaginal walls.

consistently ignored him. He had no way of obtaining patients and of making a living. His discouragement was intense and things looked very dark. On meeting a Mr. Beattie, whom he had known well in Montgomery, he related his sad story. Mr. Beattie interested himself in his difficulties and introduced him to a Mr. Henri L. Stuart, of New York, who arranged a meeting at Stuyvesant Hall in May, 1854. There Sims addressed an audience of physicians and lay people who met by invitation, and told them of the necessity of establishing a hospital for women in New York.

Following this meeting Sims obtained the support of a number of influential physicians, some of whom had originally either ignored or opposed him. Again, on the advice of Mr. Stuart and with the aid of a Mrs. Doremus, he proceeded to organize a board of lady managers, which was made up of socially prominent women. They in turn appointed a committee to rent a building and open a hospital as soon as possible. Soon after the meeting the

Mrs. Doremus and Mrs. Codwise to advise them against their undertaking and to state that such a hospital was not needed, that if established it would not last, and that this work could be performed and was performed perfectly well at the New York hospital. None the less, the hospital was opened, but from the start had no friends among the leading hospital men. Sims states, "I was called a quack and a humbug, and the hospital a fraud."

The Woman's Hospital was inaugurated at 83 Madison Avenue, New York, on May 1, 1855; it had about thirty beds. Mrs. Browne, a widow, and the sister of Mr. Henri L. Stuart, who had done so much in organizing the hospital, was appointed matron and general superintendent. During the months preceding the opening of the hospital Sims' health had been very poor; the diarrhea had returned, he was

extremely weak, and he did not entirely recover until the fall of that year.

The hospital was full from the day it

He was lavishly entertained by the surgical profession during his stay in Dublin. From there he went to Edinburgh where he was

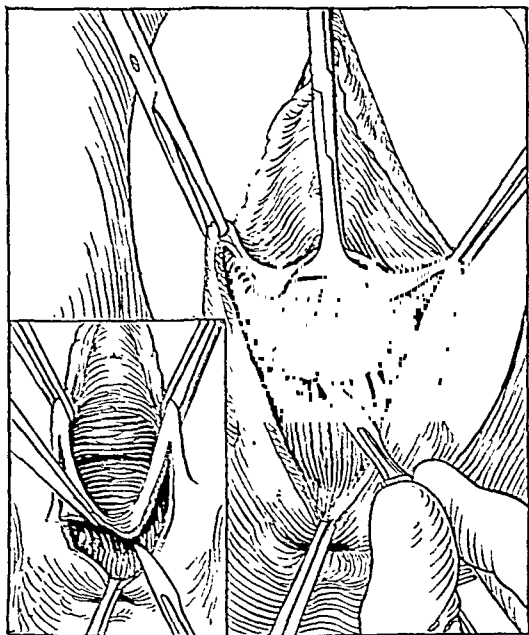


FIG. 11. The vaginal flap has been raised. Exposure of rectum and pelvic slings consisting of the levator ani muscles and their covering fascia.

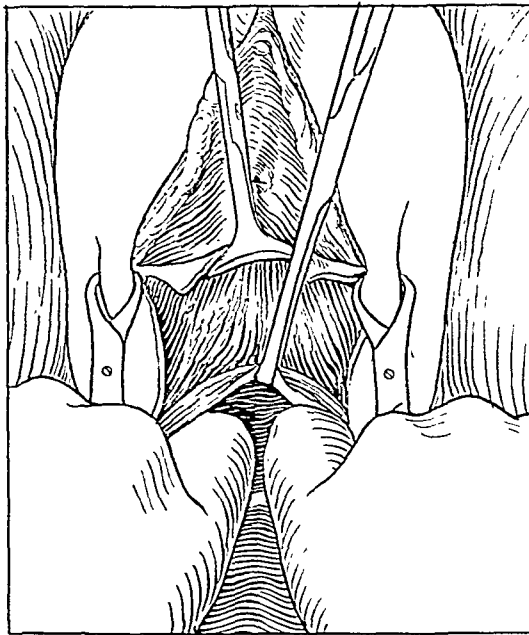


FIG. 12. The rectum is dilated so that it may be approximated without tension.

was opened and Sims, despite his illness, performed one operation a day. The hospital was a charity institution, no "pay patients" being admitted. An assistant in the person of Dr. Thomas Addis Emmet soon had to be appointed because of the large amount of work that had to be carried out. Soon after the opening of the hospital Sims' private consultation work increased, manifestly as the result of the work done in this institution. One year after the opening steps were taken to get a charter from the State for the "Woman's Hospital of the State of New York." The charter was obtained in 1857.

After the autumn of 1859 Sims had no return of the diarrhea which had weakened him from 1849 to 1855, and his health was reasonably good. Very much in need of a holiday because of his strenuous work, he went abroad for the first time in 1861, arriving at Queenstown on August 31st, and going at once to Dublin, where he stayed ten days and operated for vesicovaginal fistula at the Rotunda Hospital.

welcomed by Simpson, Syme, Chrisleston and Matthews Duncan, then a pupil of Simpson. On his visit to London he met Spencer Wells, Henry Savage, Routh and others of the Samaritan Hospital. In this institution he operated on a vesicovaginal fistula. The operation although difficult was satisfactorily done, but unfortunately the patient died five or six days later—the first patient Sims had lost after performing the operation hundreds of times. The necropsy showed that the ureters had been closed by the sutures.

Sims arrived in Paris on September 1st. Shortly afterward he met Dr. Huguier, of the Beaujon Hospital, who had a case of vesicovaginal fistula involving the neck of the bladder which had previously been operated upon unsuccessfully. Up to that time no vesicovaginal fistula had been cured in Paris. Sims operated on this woman, Huguier, Nélaton, Denonvilliers and other distinguished surgeons being present. At the end of a week the patient was cured, to the amazement of the spectators, who had believed at the time of



operation that the fistula was incurable. A few days later Sims operated in the service of Dr. Vernier at the St. Louis Hospital on

of Belgium, and the leading surgeon in Brussels, came to Paris shortly after the operation in Velpeau's service at La

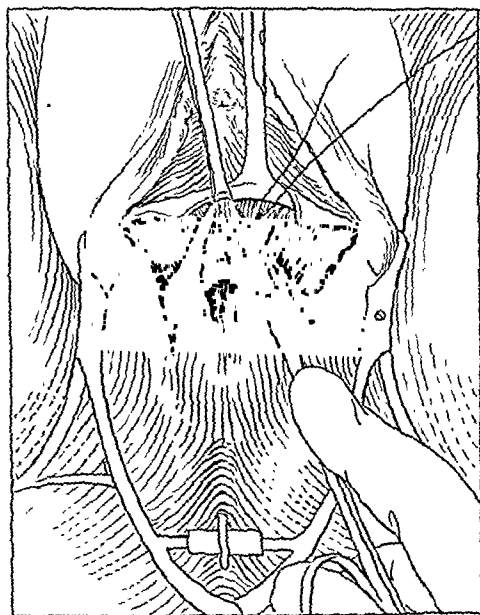


FIG. 13. The anterior rectal wall is picked up by an Allis forceps and put on stretch. The anterior rectal wall is united by interrupted sutures of fine prepared silk, the knots being tied within the bowel lumen.

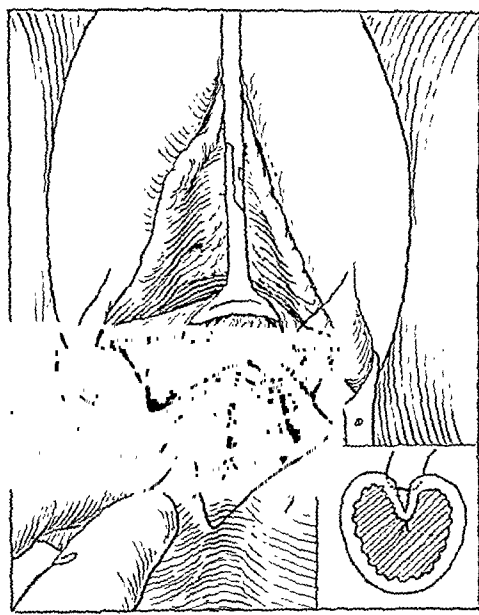


FIG. 14. Reinforcement of rectal closure. The perirectal tissues are approximated over the first suture line by a continuous suture of No. 00 chromic catgut. A second row of figure-of-eight sutures of the same material may also be used if the tissues are lax.

an enormous vesicovaginal fistula. The fundus of the bladder prolapsed through the fistula and protruded externally from the body, inverting the bladder. When the case was cured at the end of a week "it created a regular furore in the Paris hospital circles." Shortly thereafter Sims was invited by Velpeau to operate at La Charité on a young woman, who, it was said, had been operated upon seventeen times, by Joubard de Lamballe, all operations resulting in failure. The size of the fistula had been reduced by the previous operations but was large enough to allow the passage of a finger into the bladder. Although Velpeau had been told that Sims had cured three patients in Paris, he was doubtful about this fistula being closed successfully. At the end of a week the sutures were as Sims had placed them and the woman was cured, her case being the fourth successful one in three or four weeks.

Dr. Deroubaix, Surgeon to King Leopold

Charité. He had heard about the operation for vesicovaginal fistula performed in Paris and invited Sims to come to Brussels and operate for this lesion in the hospital there. The invitation was accepted and Sims went there a few days later. He did three operations in one morning. Two patients were cured; one died due to the fact that the nurse who was caring for her, inexperienced in the treatment of such conditions, forced the catheter through the posterior wall of the bladder into the peritoneal cavity, an accident that would not have occurred in the hands of a trained person.

During his stay in Brussels, Sims was elected a Corresponding Fellow of the Royal Academy of Medicine, and his name was recommended to the Government for the Legion of Honor. On his return to Paris he operated successfully upon a patient of Dr. Mungenier. The whole base of the bladder was destroyed,

the ureteral orifices could be seen ejecting the urine in spurts, and the bladder was inverted and was seen hanging outside of

base had been destroyed following the delivery of an hydrocephalic child. She was beautiful, young, rich and accomplished.

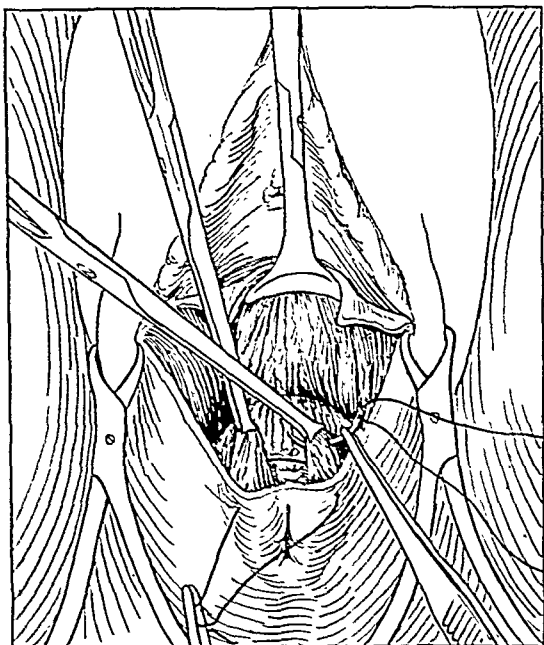


FIG. 15. The ends of the sphincter ani muscle are approximated by two interrupted sutures of No. 0 chromic catgut. A reinforcing suture of prepared silk is passed through the skin on the left, through the ends of the sphincter ani muscle and through the skin on the right. This suture acts as a splint.

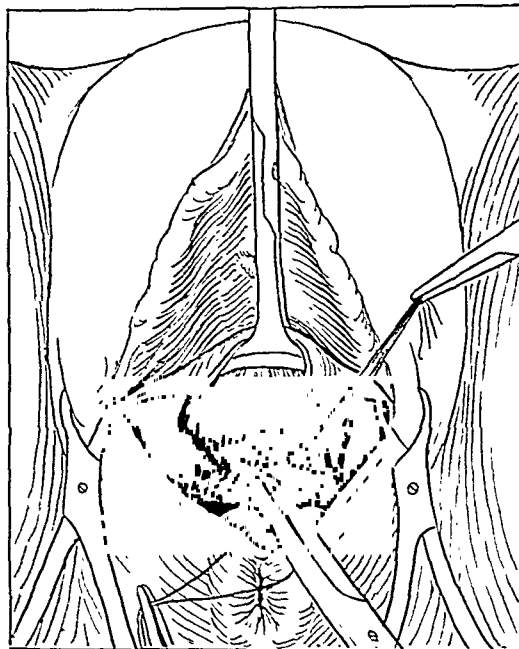


FIG. 16. The sutures in the sphincter ani are tied; the reinforcing suture is held untied.

the body as a hernial mass. Dr. Mungenier stated that he could not get a bed for this patient in any hospital, so Sims arranged to operate upon her in a room in the Hotel Voltaire. There were present at this operation Nélaton, Velpeau, Civiale, Baron Larrey, Sir Joseph Olliffe, Campbell, Huguier and other distinguished physicians of Paris, seventeen or eighteen in number. The operation required about one hour. One week later the twelve sutures used were removed and the patient was cured.

Sims had made plans to go to Vienna, but through Dr. Campbell, the great accoucheur of Paris, Nélaton had begged him to remain to see a patient of his from the South of France, her case having been pronounced incurable. On his consent to stay, the woman, who belonged to the higher walks of life, was sent for and arrived in the course of time. She was twenty-one years of age, and the bladder

Her condition was pitiful and she was praying for death in vain. The external parts were so irritated, that the lesions resembled those of confluent small pox. She took large quantities of sedatives and passed sleepless nights and restless days.

Sims having given up his trip to Vienna and having accepted Nélaton's invitation to operate on this patient, she was sent to St. Germain, one hour's distance from Paris, and the operation was performed in the presence of Nélaton, Johnstone, Campbell, Beylard and Herbert. Dr. Campbell, because of his wide experience with chloroform in obstetrics, was chosen to administer the anesthetic. During the operation the respirations ceased three times and artificial respiration was instituted under the direction of Nélaton. Finally, the breathing again became regular and the sutures were tied without anesthesia, when the patient had recovered consciousness. Eight days later Sims removed the sutures in the presence of Dr. Nélaton and the success of the operation was demonstrated.

On January 11, 1862, Sims returned to New York, where he found the country in the throes of a civil war; this made him

Empress Eugénie, the wife of Napoleon III. His skill and experience in obstetrics were responsible for his engagement to attend

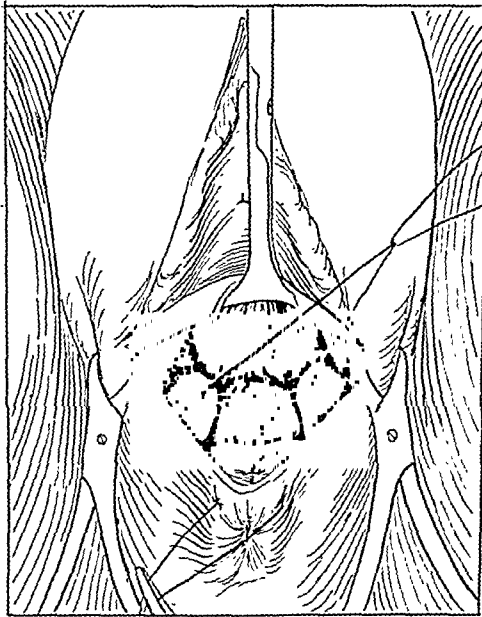


FIG. 17. The levator ani muscles and their fascia are approximated by three interrupted sutures of No. 1 chromic catgut.

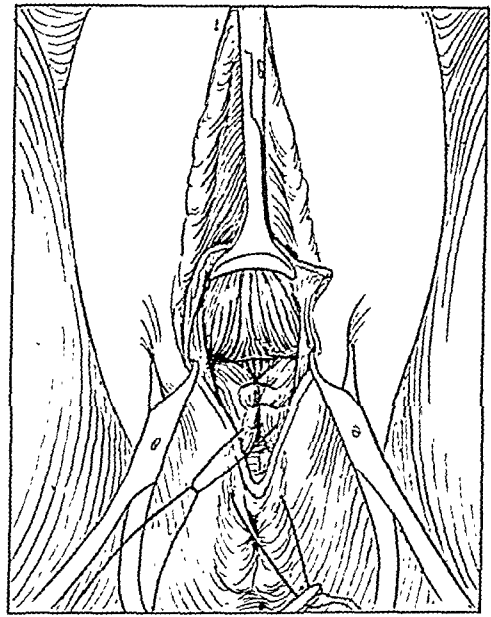


FIG. 18. The levator ani sutures are tied.

so unhappy that he decided to take his family to Europe, sailing on July 18, 1862. Through the offices of Sir Joseph Ollife he became the physician of the Duchess of Hamilton. While treating her at Baden Baden during the summer of 1863, he wrote his book, *Clinical Notes on Uterine Surgery*, which he published while residing in London, in 1865. This work was issued simultaneously from the English, German and French presses in London, Berlin and Paris. In his late memoir of Dr. Sims, Dr. Thomas Addis Emmet, of New York, wrote, "Its publication was the turning point of modern gynecology, or, more strictly speaking, American gynecology, of which he may be further termed the father." Reluctantly accepted by the profession at first, this book was instrumental in revolutionizing the specialty of gynecology. Through attending the Duke of Hamilton, who died at the Hotel Bristol in Paris, Sims became the physician of the

her accouchement and also to attend the Empress of Austria.

One severe blow which came in Sims' life was his resignation from the Woman's Hospital, which he had founded and served well for some fifteen years. This came as the result of a rule promulgated by the governors of the hospital which decreed that only fifteen guests or spectators should be permitted to be present at one operation. Dr. Sims told the governors that if they insisted on enforcing this regulation his resignation was at their disposal. He would not subscribe to this rule, which he thought interfered with the prerogatives of a surgeon, and which he believed accused him of wanting in a proper regard for the feelings and sensibilities of his patients. Unfortunately for the cause of gynecology, his resignation was accepted. The sympathy of the American medical profession in the stand he took was expressed in his unanimous election as president of the American Medical Association in Louisville, Kentucky in 1875. He was a founder of the American Gynecological Society in

1876, and its president in 1880. In 1881, Jefferson University conferred upon him the degree of Doctor of Laws. A fine marble bust of J. Marion Sims stands at Jefferson Medical College, while another marble bust cut by Dubois, of Paris, was erected at the Woman's Hospital of the State of New York. Sims was decorated by the governments of France, Italy, Germany, Spain, Portugal and Belgium. He died at his residence, 267 Madison Avenue, New York, November 13, 1883, at 3:15 A.M. at the age of seventy.

Shortly after his death a movement was started in Europe and the United States for the erection of a statue to preserve his memory. As stated by George Gray Ward, "This was a spontaneous gift from his brothers in the profession throughout the civilized world and from many of the unfortunate beings his genius and skill had benefited. South Carolina, his native state, has erected a beautiful memorial to him in Columbia."

The statue was originally erected in Bryant Park, New York. Later, when the park was repaired the statue was removed and for the time being was lost. It was finally located under the anchorage of the Brooklyn Bridge. After its rescue a new pedestal was designed for it and it now stands on Fifth Avenue at 103rd Street, directly across from the New York Academy of Medicine. The inscription on the first pedestal in Bryant Park summarized the life and inspiring career of the "Father of Gynecology." It read as follows:

*J. Marion Sims, M.D. L.L.D.*

*Born in South Carolina, 1813,*

*died in New York City in 1883.*

*Surgeon and Philanthropist*

*Founder of the Woman's Hospital  
of the State of New York*

*His brilliant achievements carried the fame  
of American Surgery throughout the civilized  
world.*

*In recognition of his services in the cause  
of science and mankind*

*He received the highest honors in the gift of  
his Countrymen*

*And decorations from the Governments of  
France, Portugal, Spain, Belgium and Italy.*

On the reverse was inscribed:

*Presented to the City of New York*

*By*

*His professional friends, loving patients*

*And*

*Many Admirers*

*Throughout the world.*

Sims' professional fame rests on four foundation stones: (1) his operation for vesicovaginal fistula with silver wire sutures, a lesion estimated as incurable before his operation; (2) the invention of the Sims speculum; (3) his exposition of the pathology and true method of cure of trismus nascentium, or lockjaw of infants; and (4) his many valuable contributions to medical literature.

In the days of J. Marion Sims all the vesicovaginal fistulas were the result of the trauma of labor. Women with contracted pelves were left in labor for a number of days, frequently with filled bladders, so that with each contraction of the uterus the bladder was firmly pressed against the symphysis pubis by the advancing and retracting presenting part. It is not to be wondered at that eventually a slough formed, resulting in the enormous fistulas which Sims described, some of them involving the whole base of the bladder. Yet, in those days there was little else that could be done at delivery. Cesarean section was almost universally fatal and was not even considered in a woman with a moderate contraction of the pelvis; and it was well that it was so, for a woman with a vesicovaginal fistula, despite her suffering, could survive, and after Sims' success in closing these fistulas in 1849, could again become a useful member of society. Most of these women in a state of exhaustion and infection after prolonged labors were delivered by forceps, and the fistulas were frequently ascribed

to the use of these instruments rather than to the sloughing of the parts from pressure necrosis. In reality, it was the withholding

operating, the female urinary bladder, which is attached anteriorly to the uterus, is necessarily exposed to injury. There has,

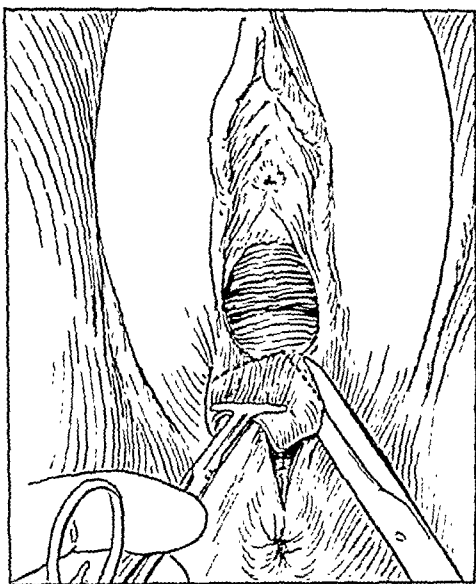


FIG. 19. The redundant posterior vaginal wall is resected. Care should be exercised that not too much posterior vaginal wall be resected, so that approximation without tension may result.

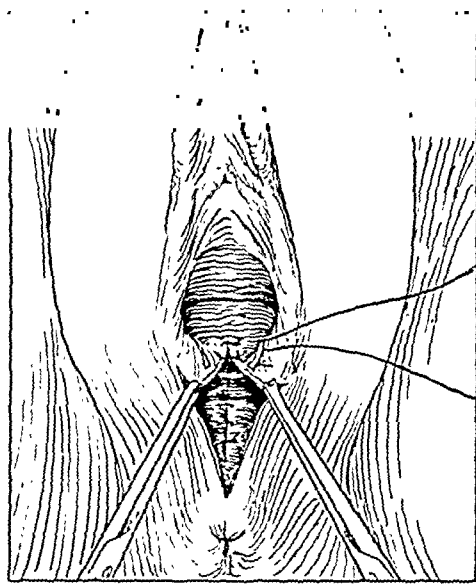


FIG. 20. The vagina is closed by interrupted sutures of No. 1 chromic catgut.

of the forceps rather than their use that was responsible for this infirmity. Bad as they were, these obstetrical fistulas had one point in their favor—they were easily located; they were usually in the median line and could be exposed for suturing after the invention of the proper instruments.

With the advent of asepsis and the improvement of obstetrics in general and especially of delivery care, large obstetrical fistulas are seldom encountered nowadays. In some cases the bladder may be ground against the pubic ramus of one side or the other by the forceps, resulting in a vesicovaginal fistula adherent to bone, a type of fistula extremely difficult to cure. I speak from experience when I say this, as I had to operate upon a young woman six times before achieving success. Because of the marked strides made in gynecological surgery during the last half century, operations on the female pelvic organs are performed daily in practically all hospitals. As a result of this tremendous amount of

therefore, developed in more recent times a type of vesicovaginal fistula that may be termed a surgical fistula, in contradistinction to the obstetrical fistula. Surgical obstetric methods, such as the vaginal cesarean section, may account for a few of these disorders. Surgical vesicovaginal fistulas may be the result of certain operative procedures such as panhysterectomy, abdominal and vaginal. Operations for the cure of cystocele and uterine prolapse, such as vaginal fixation of the uterus, the interposition operation, also known as the Watkins-Schauta-Wertheim operation, the Manchester operation and less extensive interventions on the anterior vaginal wall and bladder, may also be responsible for a number of these disorders.

Surgical fistulas result in three ways: first, by direct trauma to the bladder during operation; second, by sloughing on account of interference with the blood supply of a certain area of the bladder consequent to the operation; and third, by inclusion of the bladder wall in the suture or sutures used to close the vagina in a panhysterectomy. The last usually means

that the bladder has not been well mobilized and retracted. While it is true that direct trauma and inclusion of the bladder wall in

the vaginal route, whereas special methods, intravesical and intraperitoneal, have been devised for those that cannot be reached

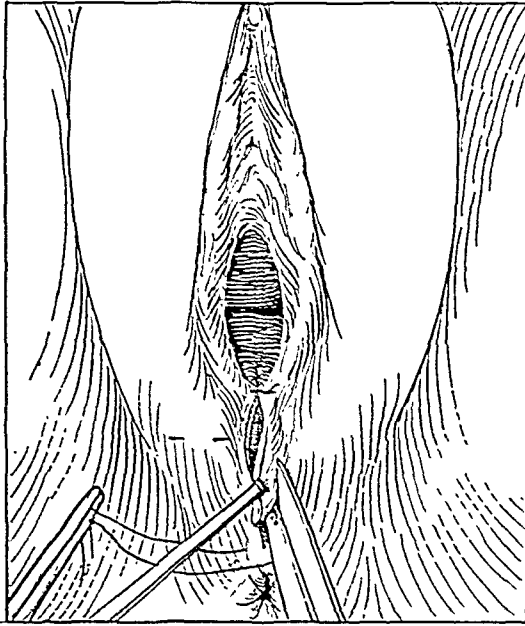


FIG. 21. The superficial perineal tissues have been approximated by a continuous suture of No. 00 chromic catgut.

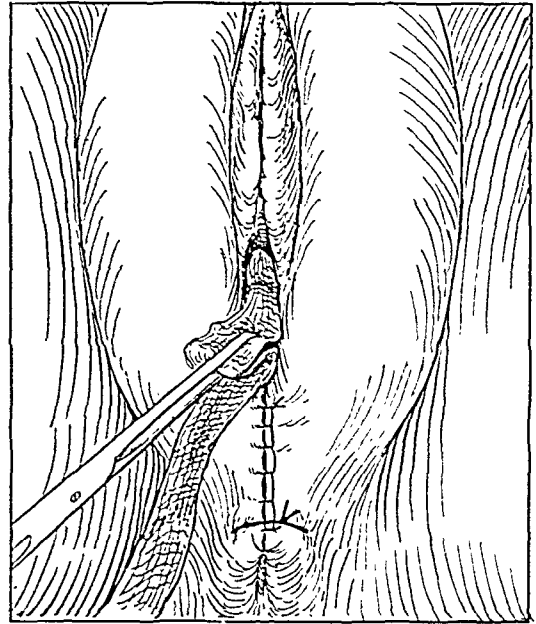


FIG. 22. The skin is closed by a continuous suture of No. 00 chromic catgut. The reinforcing suture is loosely tied. A loose iodoform gauze pack is placed in the vagina and left *in situ* for twenty-four hours.

the sutures of a hysterectomy are extremely rare in the hands of the experienced, a small slough resulting from the wide separation of the bladder in performing certain radical pelvic operations may occur even in the hands of the most experienced. When due to operative trauma, the fistula appears soon thereafter; when due to necrosis and sloughing, a number of days elapse before urinary incontinence is apparent. Syphilis, tuberculosis and carcinoma, by erosion and ulceration, may be responsible for a bladder fistula, while the constant pressure of foreign bodies, the commonest of which is the pessary, is the etiologic factor in rare cases.

Three types of fistulas offer great difficulties: those which, as previously mentioned, are adherent to bone; those which are situated high in a scarred vaginal vault, and those in which there is extensive loss of tissue.

Regardless of the difficulties encountered in operating upon surgical vesicovaginal fistulas, most of them are closed through

through the vagina. The Schuchardt incision, by the excellent exposure that it gives to the vaginal vault, high though it may be, has in my hands proved itself valuable in reaching fistulas that could not have been made accessible without it.

#### PREOPERATIVE PREPARATION

The preoperative preparation of these patients is all important. A number arrive in the hospital with phosphatic deposits on the vulva, in the vagina and on the inner aspect of the thighs. The formation of granulation tissue and ulceration are sequelae of this irritation. These areas are denuded of surface epithelium and bleed readily on friction. It is to these lesions that Sims referred when he stated that they had the appearance of confluent small pox. The parts must be brought back to a healthy state before operating, otherwise the sutures will not hold and recurrence will be the case. To obtain this desideratum the fol-

lowing régime may be employed: The urine must be acidified to prevent the further formation of phosphatic deposits. According to George Gray Ward, Thomas Addis Emmet recommended for this purpose 1 dram benzoic acid and 2 drams of sodium borate in 8 ounces of water. He gave this mixture in water, one tablespoonful three times a day for four days and one teaspoonful three times a day thereafter. Ammonium chloride and acid sodium phosphate seem to be the drugs in vogue at the present time to accomplish this purpose. Fluids are administered in large amounts. An indwelling catheter is introduced into the bladder in the hope of directing some of the urinary stream away from the inflamed parts. The urinary deposits are removed by means of warm, mildly acid irrigations, such as 1:1000 solution of acetic, hydrochloric or nitric acid. The irritated surfaces are then painted with a 10 per cent solution of silver nitrate, and the parts are protected by the free application of a bland ointment such as diachylon ointment, which I prefer, and others. With this program carefully followed it takes an average of two to three weeks to get the parts in satisfactory condition for operation.

#### SUTURE MATERIAL

Marion Sims closed his first vesicovaginal fistula by means of silver-wire sutures, because, in his own words, silver wire caused no inflammation and tumefaction in the tissues. He had succeeded with silver wire after having failed with all the suture material that he had employed heretofore. But silver wire has certain disadvantages: it has low tensile strength, it cannot be tied, it must be fixed by twisting, and it may produce a disfiguring argyria. In recent times a new noble metal, rustless alloy steel wire, has come into use. Originally proposed by W. Wayne Babcock, of Philadelphia, in the suturing of septic wounds, and recommended by him in the suture of vesicovaginal fistulas, this alloy wire has all the advantages of silver wire and none of the inconveniences. It is soft,

strong and nonirritating and does not discolor the tissues. Because of its strength a very fine-gauge suture may be used and a strong knot may readily be tied. On the recommendation of Dr. Babcock, I have substituted it for silver wire, with great satisfaction, in the management of vesicovaginal fistula. The use of catgut in human tissues causes swelling and exudation of serum and leucocytes, which in three or four days result in the formation of an adjacent necrosis, and by the end of a week in a distinct greenish layer around the catgut, thereby delaying healing until the irritating foreign body and necrotic tissues are removed or replaced. The foregoing shows why fistulas closed with catgut recurred and were subsequently successfully closed by means of metallic sutures. A method that has proved successful in my hands consists of closing the bladder opening with very fine catgut sutures, skipping the bladder mucosa, and closing the vagina with steel alloy or silver wire sutures. It is important not to resect the edges of the anterior vaginal wall before approximating them, so that in the case of a recurrence there will still be left enough anterior vaginal wall with which to work.

Many surgeons have given up metallic sutures entirely, depending exclusively on catgut, and report satisfactory results. My own experience in closing fistulas with metallic sutures, when there have been a number of failures through the use of catgut by other surgeons, has impressed me with the reliability of the metallic suture, which today is not likely to cause inflammation and tumefaction in the tissues any more than it did in 1849 when Sims closed the first vesicovaginal fistula.

#### TECHNIC OF OPERATION

Because of the complexity of vesicovaginal fistulas numerous methods of closure have had to be devised. These may be summarized as follows:

1. The vaginal procedure, including several varieties of technic.

- A. Paring the edges and closing in one layer with silver wire or alloy wire sutures.
- B. Circumcising the fistulous opening, turning the cuff into the bladder, closing the fistula by approximating the bladder musculature over the cuff without penetrating the bladder mucosa, and closing the vaginal wall separately. The vaginal wall is satisfactorily closed by means of metallic sutures placed perpendicularly to the line of bladder suture, thus staggering the suture lines.
- C. Mobilization of the bladder and closure of the bladder and vagina in separate layers.
- D. Using the cervix and body of the uterus to close the opening.
- E. Suturing pedicled flaps from the vagina and vulva to bridge over the defect.
- F. Using the gracilis muscle as a pedicle flap (Garlock technic).
- G. Colpocleisis.
2. The intravesical procedure through a suprapubic incision, best illustrated by the method of Hugh H. Young.
3. The suprapubic extraperitoneal procedure through a Pfannenstiel incision.
4. The intraperitoneal procedure through an abdominal incision (Legueu technic). This is especially useful in high fistulas following panhysterectomy, where they are inaccessible vaginally.
5. Implantation of the ureters in the sigmoid (Coffey technic), and its modifications.

#### SUPRAPUBIC BLADDER DRAINAGE

Suprapubic drainage of the bladder is an operation used daily on practically every urological service. Yet a review of the chapter on vesicovaginal fistula in most of the important textbooks of gynecology fails to show any mention of this method of bladder drainage in connection with operations for vesicovaginal fistula, except those done by the intravesical route. When used in association with the vaginal method

of repair of the bladder defects, it may render great service. I have used it during the last few years on six difficult cases and have been rewarded by its employment. In three cases it was resorted to some time before attempting the closure in order to divert the urinary stream and to get the parts in satisfactory condition for operation. In the other three cases it was used after closure of the fistula. The details of these latter cases are briefly given. The first was a urethrovaginal fistula that had failed to heal after a first operation. At the second intervention suprapubic drainage was instituted and no urine was allowed to come through the urethra for twenty-one days. The suprapubic tube was then clamped and the patient voided normally. The suprapubic incision healed rapidly after removing the catheter. The other two patients presented extremely difficult vesicovaginal fistulas, both operated upon before, one several times without success. With the aid of the Schuchardt incision both these fistulas were closed by the vaginal approach. Suprapubic drainage as described above was instituted, and both fistulas were firmly healed when the patients were allowed to void at the end of the twenty-first day. I am convinced that the more frequent use of this method of drainage would lead to happy results in the treatment of difficult fistulas.

#### POSTOPERATIVE CARE

The postoperative care is of great importance and should be carried out by the operator himself, and not left to less experienced young assistants. Except in the case of transplantation of the ureters into the sigmoid, constant bladder drainage should be instituted. This may be accomplished by introducing a catheter into the bladder through the urethra, a plain soft-rubber catheter, the wing-tip catheter and the Foley catheter all being satisfactory and employed in preference to the Pezzer catheter because of its bulbous tip. In the difficult and complicated cases, as mentioned above, suprapubic



drainage is my preference. The urethral catheter is left *in situ* for ten days; the suprapubic catheter for twenty-one days. Irrigation of the bladder with warm boric acid solution should be carried out as indicated, but no strong antiseptics should be left in the bladder. Sulfadiazine, or methenamine and acid sodium phosphate is used as a urinary antiseptic while constant drainage is maintained. Keeping the patient on her abdomen during part or all of the convalescence is of value where bladder drainage has been instituted through the urethra.

When metallic sutures are used they are removed at the end of a month, always under anesthesia; intravenous anesthesia is quite satisfactory, but general anesthesia may be used if preferred. The patient is allowed out of bed the day after the constant drainage apparatus is removed, on the eleventh or the twenty-second day, depending upon the type of drainage used; she returns to the hospital at the end of a month to have the metallic sutures removed, and may return home the same day or the day following.

#### MANAGEMENT OF RECTOVAGINAL FISTULAS AND OF COMPLETE TEARS OF THE PERINEUM

Rectovaginal fistula, an opening between the rectum and vagina, may occur independently of complete tear of the perineum or tears involving the sphincter of the anus and the anterior rectal wall. These constitute the group of smaller fistulas resulting from the direct trauma of labor or from later sloughing due to bruising of the parts and interference with their blood supply during labor. The slough occurs a few days after delivery and may heal spontaneously. When such is not the case, the fistulous tract is dissected out, turned into the rectum, the vaginal side is closed with fine catgut sutures, and the fistulous tract may be later excised through the rectum or removed by the cautery when healing has taken place.

The large and more commonly met rectovaginal fistulas are usually the result of

#### STATISTICS

Twenty-six women with vesicovaginal fistulas, nine obstetrical and seventeen surgical, came under my care. There were twenty-five attempted vaginal closures, with twenty-one successes, twenty of the latter being my own and one that of another surgeon after I had failed at a previous vaginal operation. Five patients required additional procedures that were varied in their extent. In this group of patients colpocleisis was successfully carried out in two cases. Intravesical closure was resorted to in four cases, all resulting in failures. The ureters were transplanted into the sigmoid in two cases and ureterovesical anastomosis was practiced in one, the last three operations mentioned having been performed by Dr. Rogers C. Graves, urologist-in-chief at the Carney Hospital. In one case a hemicystectomy was done for tuberculosis of the bladder. There were six suprapubic cystostomies, three before closure of the fistula and three after it. The Schuchardt incision, for exposure, was employed in eight cases.

imperfect healing after the repair of a laceration of the perineum, involving the anal sphincter and the anterior rectal wall. All varieties of fistula may be found, depending upon the type of imperfect healing that has taken place. The simplest way of handling this condition, in my experience, consists of incising the perineum in the median line, above and below the fistula, thus reduplicating the original complete tear through the sphincter ani and the rectovaginal septum, and proceeding again with the repair of a complete laceration. Because of the close association of the fistulas with the lacerations of the perineum involving the sphincter ani and the anterior wall of the rectum, the operative care of these lesions will be stressed in this article.

Lacerations of the pelvic floor may be incomplete, when they do not involve the

sphincter of the anus or complete, when they extend through the sphincter and frequently through the anterior rectal wall. Rarely are they the result of external trauma; commonly they are consecutive to the injuries of childbirth. They may occur in children as well as in adults. I<sup>17</sup> have operated upon three female children, aged eight, seven and seven years, respectively, for lacerations through the sphincter ani in two cases, and extending to the side of and exposing the sphincter in 1. These were due to being impaled on an iron picket fence in one case, to rape in another, and to being cut by an automobile fender in still another. The injuries in adults are usually the result of the trauma of labor and, despite the improvement of obstetric practice, they are still frequently encountered.

Thomas Addis Emmet,<sup>13</sup> in his original article in 1883, divided injuries of the pelvic floor into two main groups: median-line lacerations of the perineum, the importance of which is directly related to the amount of injury to the function of the anal sphincter muscle; and injuries to the pelvic fascia and the levator ani muscle—the sulcus tears—which result in the crippling of an important function of the posterior vaginal segment, namely, the ability to close the vaginal orifice. In this paper we are concerned with the first group, the median-line lacerations involving the sphincter ani and frequently the anterior rectal wall. The principle in repair of such injuries is well stated by George Gray Ward:<sup>15</sup> "In this type the nature of the injury is apparent and the principle of its cure is simple, although its attainment is difficult owing to the septic field. The sphincter ani muscle may be compared to the letter o. The median-line tear of the perineal body becomes serious as it invades this muscle and impairs its integrity. When torn completely through, the torn ends of the muscle spring apart and it is converted into a letter u and a loss of control of feces and flatus results. The principle of cure is obviously to unite the separated

ends of the muscle, reconverting the u into the original o, thus restoring its function."

There are two general methods advocated in the repair of complete tears of the perineum and their accompanying recto-vaginal fistulas: the apron or flap method, and the layer-suture method with or without rectal sutures. The former was advocated by J. Collins Warren,<sup>11,12</sup> of Boston, in 1878, and presented before the American Gynecological Society in 1882. This mode of operating was accepted and elaborated upon by Kelly, Ristine, Ward, Farrar, Norman Miller, Ralph E. Campbell and many others. From the start I have employed the layer-suture method with rectal sutures, and since my results have been satisfactory, I have not had occasion to change. Some operators, as Royston,<sup>14</sup> favor continuous sutures, whereas my<sup>16</sup> preference is given to interrupted sutures except in the skin, where I use a running stitch of very fine chromic catgut. The only exception to this rule is in the rare instance when, because of scarring, there is tension on the skin, when I resort to interrupted sutures of fine chromic catgut or fine prepared silk.

#### PROPHYLAXIS

The literature of the last quarter of a century frequently calls attention to the prevention of complete lacerations of the perineum; obviously this distressing complication of childbirth may be avoided, in most instances, by using certain measures during delivery. Two types of preventive measures are advocated to forestall this accident: first, incisions of the perineum; and second, manual dilatation of the perineum and the vagina. Two types of incisions are recommended: the median incision known as perineotomy and the lateral or mediolateral incision, known as episiotomy. The advantages of the median incision are that it is easier to repair and that it leaves a more elastic perineum. Its main disadvantage is that if it extends during delivery the sphincter ani may be

injured. This, however, may be easily overcome by encircling the anus on one side or the other, so that the sphincter retracts toward the opposite side. As a rule the lateral incision is employed when considerable room is required and the median incision when the opposite is true. The lateral incision is practiced on the side toward which the occiput points, or, to put it another way, a right episiotomy in a right position and a left episiotomy in a left position. Under unusual circumstances it may be necessary to incise the two sides.

Whereas perineal incisions are usually employed in primiparae, they sometimes become indicated in multiparae. A multipara who was subjected to an episiotomy or an extensive pelvic floor repair with her first accouchement appears at a second delivery with external genitals resembling those of a primipara, and in addition has a scar caused by the union of the severed tissues, again necessitating an incision at the present childbirth. This principle also applies to a multipara who has been subjected to an extensive perineal repair previous to the delivery in question.

#### PERINEAL INCISIONS VERSUS MANUAL DILATATION OF THE PERINEUM

Those who advocate manual dilatation of the perineum and vagina before delivery believe that this procedure makes perineal incisions unnecessary. Doubtless this maneuver will overcome the resistance of the perineum, but it frequently is responsible for the separation of the levator ani muscles under the intact mucous membrane and skin. Because of the separation of the levator ani muscles, a rectocele soon appears; this disorder is practically never observed after well reconstructed perineal incisions.

A rectocele in connection with complete lacerations of the perineum is seldom observed. This tends to prove that it is not the tearing of the perineum that is responsible for the defect, but rather the stretching and relaxation of the fascial structures of the posterior vaginal segment.

#### IMMEDIATE VERSUS LATE REPAIR

It is advisable to repair this type of laceration immediately after the third stage of labor when the patient is seen at delivery or immediately thereafter. As a rule the puerperium is not prolonged or complicated by this intervention. If, however, the parturient is not seen soon after delivery, at least three months are allowed to elapse before operating. At this time involution has taken place, the edema has subsided, scar tissue has formed between the torn edges, and a more satisfactory repair can be carried out than when operation is attempted a few days after labor.

#### PREOPERATIVE PREPARATION

The preoperative preparation consists of thorough catharsis, by means of castor oil, prescribed four days and two days before operation. A saline, cleansing enema is given the afternoon before but none the morning of operation, and for the two preceding days a low-residue diet is advised. The preparation of the operative field is carried out under anesthesia and consists of gently scrubbing the external genitals and the vagina with tincture of green soap and warm sterile water, using gauze at the end of a sponge forceps. This is followed by irrigation with a 1:1000 solution of potassium mercuric iodide after which the parts are dried and painted with tincture of zephiran. The sterile drapings are then applied and the patient is ready for operation.

#### TECHNIC OF OPERATION

The pelvic floor is opened by an H-shaped incision. The lateral incision on each side extends from a point below the duct of the vulvovaginal gland to the retracted end of the sphincter muscle. The transverse incision joins the two lateral ones by running through the scarred rectovaginal septum. A flap of the posterior vaginal wall is dissected upward, exposing the rectum, which is separated from the levator ani muscles by blunt dissection. A second pair of sterile gloves is put on and the rectum and torn

sphincter are dilated, after which the extra gloves are discarded. The anterior rectal wall is picked up by an Allis forceps at the upper angle of the tear and put on stretch, the scar tissue is trimmed from the edges, and the torn edges are united by interrupted sutures of fine prepared silk (Kaldermic), the knots being tied within the bowel lumen. The perirectal tissues are approximated over the first suture line by a continuous stitch of No. 00 chromic catgut, avoiding constriction of the tissues. If the perirectal tissues are lax, they are further approximated by a series of figure-of-eight sutures of No. 00 chromic catgut. This layer is omitted if the tissues are moderately tense. The torn ends of the sphincter muscle are dissected out of their bed of scar tissue and approximated with two interrupted sutures of No. 0 chromic catgut tied so as not to constrict this structure. A reinforcing suture of prepared silk (Kaldermic) is introduced by passing it through the skin on the left side, the united ends of the sphincter ani and the skin on the right side, and is tied at the completion of the operation. The levator ani muscles and their fascia are approximated by three interrupted sutures of No. 1 chromic catgut, the excess of the posterior vaginal wall is resected, and the edges of the vaginal incision are united with No. 1 chromic catgut interruptedly. The triangular ligament is approximated by a running stitch of No. 00 tanned catgut. The skin may be closed in one of three ways: by a continuous or subcuticular stitch of No. 00 tanned catgut; by interrupted sutures of No. 00 tanned catgut, which in their course pick up the deeper tissues to obliterate dead space; and, if there have been previous attempts at repair and if considerable scar tissue is present, by interrupted fine prepared silk sutures. The splinting silk stitch in the sphincter ani is loosely tied. The vagina is loosely packed with iodoform gauze, which is removed at the end of twenty-four hours. Emphasis must be placed on fine suture material and approximation without tension. As my ex-

perience with this operation has increased, I have used finer and finer suture material.\*

#### POSTOPERATIVE CARE

Morphine sulphate and deodorized tincture of opium are prescribed as necessary. For the first six days the diet consists of hot and cold fluids without residue, such as beef tea, strained soup, bouillon, the white of an egg with two ounces of strained orange juice and water to make four ounces, tea with lemon and black coffee. Milk is not allowed. The external suture line is painted with aqueous solution of zephiran after micturition or catheterization. After forty-eight hours a warm douche consisting of a teaspoonful (4.0 Gm.) of compound zinc sulfate powder, National Formulary, VIIth revision, dissolved in a quart (1,000 cc.) of warm water, is given daily, using a soft rubber catheter as a tip. On the morning of the seventh postoperative day the patient is given a seidlitz powder. One-half hour later six ounces of warm sweet oil is instilled into the rectum and retained. The patient is given a low soap-suds or saline enema when the desire to empty the bowels becomes apparent and is instructed not to strain. Following this a soft diet is allowed and by the ninth day a full diet. The silk sutures, if employed, are removed on the ninth day; the patient is allowed out of bed on the twelfth day and usually discharged on the fourteenth or fifteenth postoperative day, to be re-examined four weeks later.

TABLE I  
COMPLETE LACERATION OF THE PERINEUM AND  
RECTOVAGINAL FISTULA  
Summary of Cases

Fresh complete laceration of the perineum.....	9
Old complete laceration of the perineum.....	40
Complete laceration of the perineum with involvement of anterior rectal wall.....	41
Complete laceration of the perineum with involvement of anterior and posterior rectal walls.....	1
Complete laceration of the perineum with rectovaginal fistula.....	10
Rectovaginal fistula.....	9
Total.....	110

\* The illustrations of this operation were made by the artist of *Modern Medicine* from a film produced by Davis & Geck, entitled—"Complete laceration of the perineum" by L. E. Phaneuf.

TABLE II  
COMPLETE LACERATION OF THE PERINEUM AND  
RECTOVAGINAL FISTULA

Etiology

Complete laceration, child 7 years of age, impaled on an iron picket fence.....	1
Complete laceration, child 7 years of age, following rape.....	1
Rectovaginal fistula following a perineotomy for vaginismus.....	1
Rectovaginal fistula following an operation for fistula in ano.....	1
Rectovaginal fistula following a perineorrhaphy..	1
Complete laceration and rectovaginal fistula resulting from the trauma of labor.....	105
Total.....	110

TABLE III  
PREVIOUS UNSUCCESSFUL REPAIRS

Secondary

One previous unsuccessful repair.....	10
Two previous unsuccessful repairs.....	3
Three previous unsuccessful repairs.....	1
Total.....	14

TABLE IV  
ADDITIONAL LESIONS IN THE GROUP OF 101 PATIENTS  
WITH OLD COMPLETE LACERATION OF THE  
PERINEUM AND RECTOVAGINAL FISTULA

Laceration of right labium minus.....	1
Prolapse of rectum.....	5
Rectal polyp.....	1
External thrombotic hemorrhoid.....	1
Rectocele.....	4
Cystocele.....	17
Vesicovaginal fistula.....	2
Relaxed vesical sphincter.....	2
Laceration of cervix.....	33
Erosion of cervix.....	8
Stenosis of cervix.....	1
Infravaginal hypertrophy of cervix.....	1
Prolapse of cervical stump.....	1
Cervical polyp.....	2
Hypertrophied cervix.....	2
Myoma uteri.....	1
Myometrial hypertrophy.....	1
Third degree prolapse of uterus.....	3
Second degree prolapse of uterus.....	3
Descensus uteri.....	2
Third degree retroversion.....	1
Second degree retroversion.....	2

*Note.* Two laparotomies for suspension of the uterus, and in connection with one of them shortening of the uterosacral ligaments, were performed two weeks after the plastic repair. The Moschcowitz operation for prolapse of the rectum and fundic hysterectomy were done two weeks before the reconstruction of the complete tear of the perineum.

One hundred eighteen additional operations were performed in this group of 101 patients with old complete lacerations of the perineum

TABLE V  
ADDITIONAL OPERATIONS IN THE GROUP OF 101 PATIENTS  
WITH OLD COMPLETE LACERATION OF THE  
PERINEUM AND RECTOVAGINAL FISTULA

Repair of right labium minus.....	1
Moschcowitz operation for prolapse of rectum, fundic hysterectomy, bilateral salpingo-oophorectomy, bladder advancement, abdominal fixation of uterus.....	1
Excision of rectal polyp.....	1
Evacuation of clot from external thrombotic hemorrhoid.....	1
Kelly operation for relaxed vesical sphincter.....	1
Kennedy operation for relaxed vesical sphincter..	1
Closure of vesicovaginal fistula.....	2
Resection of suburethral fold.....	1
Operation for cystocele.....	10
Dilatation and curettage.....	38
Cauterization of cervix.....	4
Conization of cervix.....	1
Cervical polypectomy.....	2
Right trachelorrhaphy.....	2
Bilateral trachelorrhaphy.....	23
Shroeder amputation of cervix.....	2
Amputation of cervix.....	11
Vaginal trachelectomy for prolapse of cervical stump.....	1
Interposition operation.....	7
Vaginal hysterectomy.....	4
Manchester operation.....	1
Round ligament suspension of uterus.....	2
Shortening of uterosacral ligaments.....	1
Total additional operations.....	118

and rectovaginal fistula, as depicted in Table v. Three laparotomies were performed. In one patient the uterus was suspended, in a second patient the uterosacral ligaments were shortened and the uterus was suspended, and in a third patient the Moschcowitz operation for prolapse of the rectum and a fundic hysterectomy were resorted to two weeks before the reconstruction of the complete tear of the perineum. For obvious reasons an abdominal operation should not be performed in conjunction with the reconstruction of a perineum lacerated in the third degree. Table II summarizes the etiology of the 110 cases.

The case of the first child, seven years of age, who had a complete laceration of the perineum with involvement of the rectovaginal septum as the result of having been impaled on an iron picket fence, is interesting from two standpoints. If in a child of that age reconstruction of the parts is not carried out soon after the accident, and scar tissue is allowed to form, it becomes increasingly difficult to secure a satisfactory repair. If a successful repair is not attained, there is imperfect development of the lower rectum, anus and external

genitals. In this particular case it was necessary to obtain needles small enough to work with from the eye department of the hospital. Healing took place by first intention and a satisfactory anus, perineum and vagina were secured. The patient was seen for some time after operation but then disappeared. Eleven years later, when she was eighteen years old, she reported to the clinic complaining of dysmenorrhea. Examination then showed perfectly developed external genitals and anus. An examination made fifteen years after operation, when she was twenty-two years old, again confirmed these findings, and in both instances the scar in the perineum could not be identified. One hundred five of the cases followed the trauma of childbirth, the usual etiologic factor. Complete laceration of the perineum and rectovaginal fistula is frequently complicated by other lesions.

Table IV shows that in the 101 patients who had old lacerations and fistulas there were ninety-four additional lesions.

TABLE VI COMPLETE LACERATION OF THE PERINEUM AND RECTO- VAGINAL FISTULA Postoperative Complications	
Rectovaginal fistula.....	6
Ischiorectal abscess with rectovaginal fistula.....	2
Ischiorectal abscess with perineal sinus.....	1
Slight separation of sphincter ends.....	1
Small area of skin slough above sphincter ani.....	1
Skin separation above sphincter ani.....	3
Hypertrophied tabs of rectal mucosa.....	1
Complete separation of rectum, sphincter ani and perineal muscles from lack of healing.....	1

Sixteen patients had postoperative complications. They were treated as follows:

- Case 1. Small rectovaginal fistula, repaired ten months later, satisfactory end result.
- Case 2. Small rectovaginal fistula, repaired five months later, satisfactory end result.
- Case 3. Small area of skin slough above sphincter ani. Satisfactory healing by second intention.
- Case 4. Small rectovaginal fistula, repaired seven months later, satisfactory end result.
- Case 5. Ischiorectal abscess with perineal sinus, right. Incision and drainage four months after original operation; healing satisfactory.

- Case 6. Slight separation of sphincter ends, healing by scar tissue; good bowel control.
- Case 7. Small high rectovaginal fistula. This patient had been operated upon for a large rectovaginal fistula which had followed a perineotomy for vaginismus. She was lost sight of.
- Case 8. Seventy years of age. Convalescence complicated by bronchopneumonia and coronary disease. Discharged from the hospital with a small rectovaginal fistula. She has refused to report for examination.
- Case 9. Perineal sinus, healed by second intention; satisfactory end result.
- Case 10. Ischiorectal abscess with fistula two months after operation. Excision of fistula, healing by second intention; satisfactory end result.
- Case 11. Hypertrophied tabs of rectal mucosa developing after operation. Injection of tabs with sclerosing solution; satisfactory result.
- Case 12. Small ischiorectal abscess and fistula, left, seven months after operation. Spontaneous drainage, healing by second intention; satisfactory end result.
- Case 13. Infection of skin around anus, healing by second intention; satisfactory end result.
- Case 14. Small rectovaginal fistula operated upon twice; small recurrence each time; healed spontaneously; satisfactory end result.
- Case 15. Slight separation of skin above anus; healing by second intention; satisfactory end result.
- Case 16. Complete separation of rectum, sphincter ani and perineal muscles due to poor healing of tissues; no infection. One month previously she had had a successful repair of a large vesicovaginal fistula consecutive to an abdominal panhysterectomy. She was a thin, asthenic woman in poor physical condition. Ten days after first operation a second repair was done using Alloy wire sutures. Large doses of vitamin c were prescribed; good healing. Check-up one year later showed a good sphincter and perineum and perfect bowel control.

TABLE VII  
COMPLETE LACERATION OF THE PERINEUM AND RECTO-  
VAGINAL FISTULA  
End Results

One hundred ten patients were operated upon, nine for fresh lacerations and one hundred one for old lacerations or rectovaginal fistulas.

The criteria of a satisfactory result are five in number; namely: a healed rectum, a healed rectovaginal fistula when present, a reconstructed anal sphincter, bowel control and a firm but elastic perineal body.

The nine patients operated upon for fresh lacerations had firm healing, without complications, and a satisfactory end result was obtained.

The one hundred one patients operated upon for old complete lacerations or rectovaginal fistulas had sixteen postoperative complications:

8 patients who had postoperative complications had additional operative procedures, and satisfactory end results were secured.

8 patients who had postoperative complications had healing by second intention, as explained in Table VI, and satisfactory end results were secured.

The final result in one hundred eight of one hundred ten patients, 98 per cent, was satisfactory.

The final result was doubtful in two patients with small rectovaginal fistulas when discharged from the hospital, 2 per cent, as no follow-up could be obtained.

#### SUMMARY AND CONCLUSIONS

The life of J. Marion Sims, called the "Father of Gynecology," is reviewed, and the story of vesicovaginal fistula is depicted. During Sims' days vesicovaginal fistula was almost entirely of obstetric origin, but since then, with the advent of asepsis, so many surgical operations are performed on the female pelvic organs that most of the vesicovaginal fistulas encountered are of surgical rather than obstetrical origin. The first successful operation for this distressing malady was performed by Sims on a slave girl in 1849, this being the thirtieth operation that he had performed on this patient. His success was due to the use of silver-wire sutures, failures having been encountered in the previous twenty-nine operations, when he had used other suture material. His operation has been responsible for restoring women so afflicted to a useful life by overcoming one of the most tormenting disorders to which womankind may be subjected. The story of his life shows how

obstacles that seemed insurmountable were overcome.

The preparation of the patient and the after-care are described and twenty-six personal cases are reported. The cure of vesicovaginal fistula depends upon careful preoperative preparation, meticulous technique, attention to small details and painstaking postoperative care, preferably in the hands of the operator himself.

A complete laceration of the perineum and its frequently accompanying rectovaginal fistula may be prevented by resorting to one of three methods when the indication arises: perineotomy, episiotomy, or manual dilatation of the perineum and vagina.

Perineotomy or median perineal incision is valuable when the disproportion between the presenting part and the vaginal outlet is moderate.

Episiotomy, or lateral perineal incision, should be employed when a great deal of room is required, as in difficult forceps operations, and in the presence of a large presenting part.

Manual dilatation of the perineum and vagina is a satisfactory method of preparing the birth canal before version and extraction operations.

The technic of operation for repair of complete laceration of the perineum and rectovaginal fistula is discussed.

The preoperative and postoperative care are described.

The gentle handling of the tissues and their careful approximation with fine suture material applied without tension is stressed.

One hundred ten personal cases are reported.

The end result was satisfactory in 108 patients, 98 per cent, sixteen of whom, 15 per cent, developed postoperative complications. In two patients, approximately 2 per cent, discharged from the hospital with small rectovaginal fistulas, the final result could not be ascertained.

Sulfasuxidine, administered two weeks preoperatively and postoperatively, as soon

as tolerated, may modify the intestinal bacterial flora in such a way that it may further reduce postoperative infections.

A careful preoperative preparation, meticulous technic, gentle handling of the tissues, sharp rather than blunt dissection when feasible and postoperative care under the immediate supervision of the operator all play an important rôle in securing satisfactory healing.

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# THE USE OF CARBOLIC ACID (PHENOL) IN THE TREATMENT OF BARTHOLINIAN ABSCESS

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THIS short communication is concerned with the treatment of Bartholinian abscess by incision and use of carbolic acid (phenol).

cure of a Bartholinian abscess, although there is mention of its use in many similar conditions.

The evacuation of a Bartholinian abscess

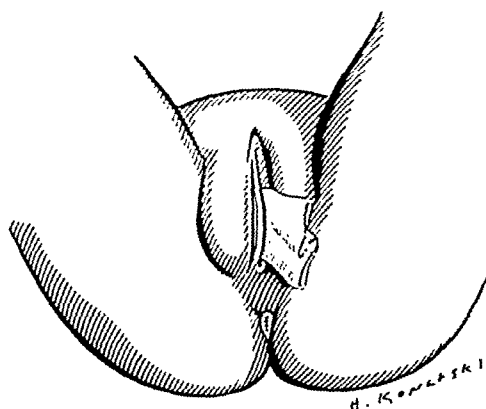


FIG. 1. Gauze or cotton placed in the vagina. The incision of the abscess is at the junction of the skin and mucous membrane.

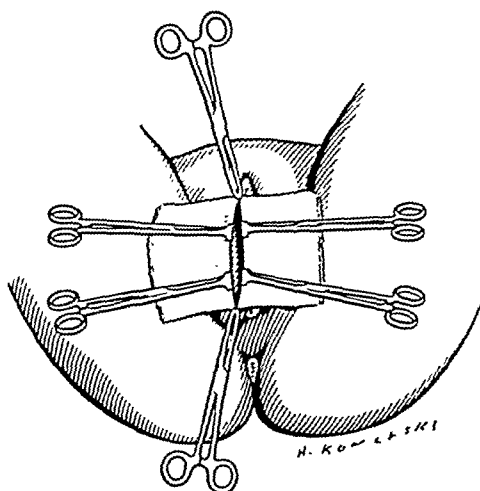


FIG. 2. After incision and evacuation of the abscess alcohol gauze is applied to the wound edges with Allis clamps.

Caspar Thormerson Bartholinus (1655-1738), born in Copenhagen, was the first anatomist to describe the glands which bear his name. In the years following his death there has been much controversy concerning their function and their relation to gonorrheal infection. Not so long ago it was believed that all infections of these glands were of gonorrheal origin. Today it is generally held that not more than 60 or 70 per cent of Bartholinian abscesses are of gonorrheal origin. This has been the writer's experience.

In a review of my own clinical experience, and of the writings of the old clinicians whose methods have been lost sight of, I can find no mention of this method (i.e., the use of phenol) in the

is a simple matter but the permanent cure of the same is another story. An evacuation may at times cure the condition, especially if the abscess cavity is packed following the evacuation. This method is not to be recommended, despite a few cures, because recurrences are too frequent. The desire to enucleate the gland and its contents must be equally condemned as infection almost invariably ensues, leaving in its wake a distorted vulva.

"Like all compound glands, it is surrounded by connective tissue which forms a more or less definite capsule."<sup>1</sup>

Despite the toxicity of carbolic acid, which is textbook knowledge, we have found its use safe according to the technic

we employ in the cure of these abscesses. Careful analysis of the urine in our laboratory has failed to show any sign of carbolic

the cut edges approximated by reversing the handles of the clamps, already applied (Fig. 4), to hold the alcohol gauze. The

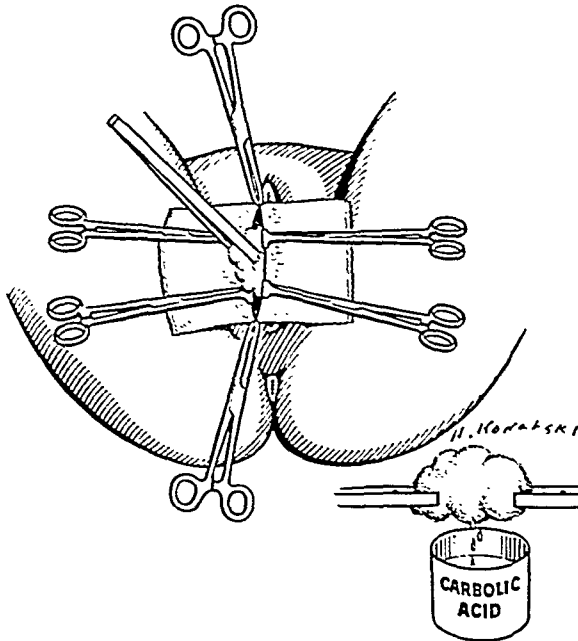


FIG. 3. Insertion of carbolized cotton to abscess cavity. Smaller illustration shows method of removing excess phenol.

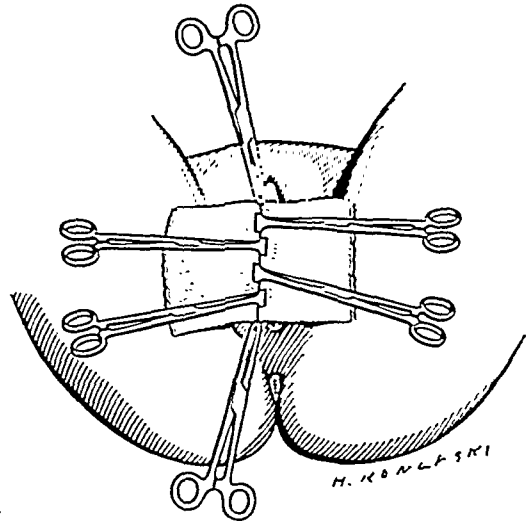


FIG. 4. The handles of the Allis clamps reversed while carbolized pack is in abscess cavity.

acid excretion in any case, and at no time has any patient shown, symptomatically, signs of carbolic acid poisoning.

*Technic.* The orifice of the vagina should first be packed with a small insert of cotton or gauze. (Fig. 1.) The egg-shaped mass of the vulva, the site of the abscess, is excised from top to bottom, the line of incision following the junction of the vulva squamous epithelium with that of the mucous membrane. The gloved finger is then introduced and, with gauze, the abscess cavity is evacuated.

Two 4 by 4 inch gauze dressings are dipped in alcohol, wrung out, and attached to the cut edges with Allis clamps. (Fig. 2.) This prevents the acid's excoriating the skin or mucous membrane.

Next, a bolus of cotton, approximately the size of the abscess cavity, is dipped in carbolic acid and the excess squeezed out, using forceps. (Fig. 3.) (*Warning: Be sure not to handle this bolus with the gloved hand.*) The impregnated cotton is now inserted into the abscess cavity and

impregnated cotton is allowed to remain in the cavity *one and a half minutes* and is then removed. The cavity is then swabbed with alcohol.

Inspection is now made to see that the eschar is complete. If any point is found not carbolized, this can be accomplished by a little carbolized cotton on the end of a probe. The cavity is now packed with plain or iodoform gauze, and the edges of the incision are approximated with two plain catgut sutures. (Fig. 5.)

A local anesthetic is not satisfactory. We have used either gas, epival or other intravenous anesthetics, as the operation should not take more than ten to fifteen minutes. The only preparation for this operation is shaving of the vulva. We still use an application of iodine to the parts before incision is made. We leave the cotton or gauze in the vagina until the end of the operation, when it is removed.

After the operation, the patient is placed on an unrestricted diet, with fluids as desired.

Little or no pain is encountered until the third or fourth day, at which time the patient complains of tenderness and at

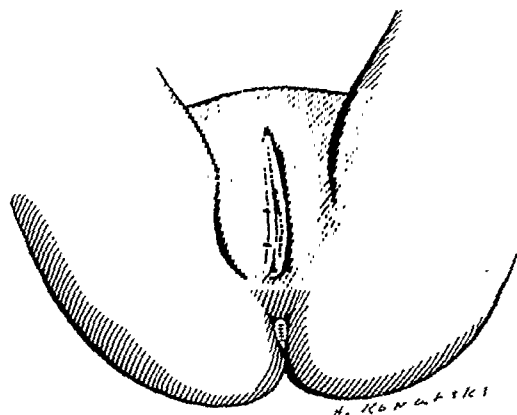


FIG. 5. The carbolyzed pack has been removed, the cavity swabbed out with alcohol, the cavity repacked with plain or iodoform gauze and the wound sutured with two plain cat-gut sutures.

times pain. At this time the sutures are cut; the packing, moistened with peroxide, are removed and another light packing is inserted. The patient is now allowed to go home and is instructed to return to the office for ambulatory treatment, which consists of repacking every other day.

Usually within two weeks the abscess cavity is entirely obliterated, healing consummated, and little or no scar results.

We have used this method of treatment for the last ten years. Recurrences have been nil, distortion of the vulva nonexistent, and as far as the patient is concerned, the operation is without subsequent pain.

This technic is used not only in our clinic, but in the College Division of Kings County Hospital, and at Greenpoint Hospital.

#### CONCLUSION

The technic of the treatment of Bartholinian abscess by incision, drainage, and the use of carbolic acid, together with the after-treatment is described. This treatment has given satisfactory results in our clinic for the past ten years. The simplicity of the technic is a real recommendation.

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# CONTINUOUS CAUDAL ANESTHESIA IN OBSTETRICS\*

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THE relief of pain during labor has been the subject of much discussion, clinical observation and research in the past half century. It is true that some labors are short and the pain is well tolerated; yet, many labors are prolonged, and the patients desire and expect freedom from pain or some amelioration of their suffering. Relief of pain is more readily resorted to in most other conditions. Reluctance to the use of pain-relieving measures in obstetrics is apparently due to the possible effect on the parturient and the fetus. Refinement in surgical procedures followed the improvement in methods of anesthesia and the discovery of new anesthetic agents. Surgery, the spearhead of medical progress, can be said to have made most of its expansion because of the advancements in anesthesia.

In obstetrics, a suitable pain-relieving agent is sought that will also be safe for the mother and baby, and will not interfere with the normal processes of labor. Many forms of obstetric analgesia have been used in the past and many clinics have adopted one or a combination of more than one and have applied them efficiently with marked success. Most of these provide amnesia or loss of memory during the first stage of labor; but for the completion of the second stage, in most instances, an inhalation anesthetic is usually necessary. This latter procedure invariably causes marked depression of the respiratory center of the newborn resulting in asphyxia. In many instances, it has had a similarly bad effect on the respirations of the parturient causing pulmonary complications, respiratory depression and

even death. General anesthesia, moreover, is known to cause relaxation of the uterus with concomitant increase in uterine bleeding. The value of a method that will produce relief of pain during the first stage of labor, permit painless progress of the second stage, and still serve as an adequate anesthetic during delivery, whether spontaneous or operative, approaches closely to the needs of the accoucheur.

It is universally agreed that the various methods of anesthesia and analgesia in obstetrics heretofore in vogue fall short of meeting the above requirements of safety to mother and baby. One after another has been tried. Each had its day and each was discarded or used under compulsion for want of anything better.

The use of caudal anesthesia in obstetrics dates back to 1909 when Stoeckel<sup>1</sup> applied it to relieve pains during labor. Prior to that, it was attempted by Cathelin,<sup>2</sup> in 1900, when he blocked the sacral and coccygeal nerves through the sacral hiatus for pelvic and perineal surgical procedures. This method of anesthesia did not have many followers at first; but after the work of Löwen,<sup>3</sup> in 1910, it became more acceptable. Continuous caudal analgesia, as described by Hingson and Edwards<sup>4</sup> seems to answer all the requirements of a satisfactory obstetrical analgesic and anesthetic.

Many attempts have been made before to secure high anesthesia by increasing the quantity of anesthetic fluid and by increasing the force of injection. This has met with a great many failures. Attempts at placing the patient in the Trendelenburg position has also met with failure. The reason for these failures has been thought to be due

\* From the Department of Obstetrics and Gynecology, Dr. A. Koplowitz, Director, and the Department of Anesthesia, Beth-El Hospital, Brooklyn, N. Y. Read before the Brooklyn Gynecological Society, December 3, 1943.

to the relatively firm connective tissue attachment between the inner wall of the vertebral canal and the dural sac, hinder-

The dural sac extends downward only to the second sacral segment. (Fig. 2.)

The effect of caudal block on nerves

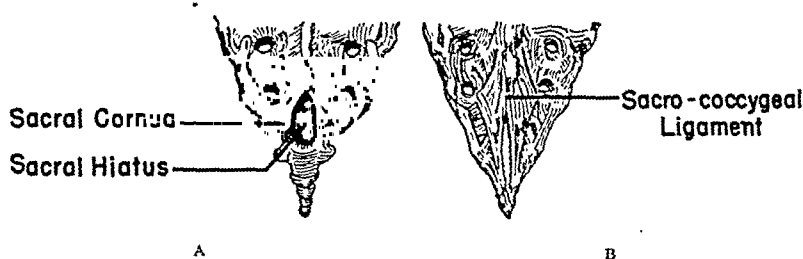


FIG. 1. Anatomical landmarks. A, cornua of sacrum and sacral hiatus. B, sacrococcygeal ligament covering hiatus.

ing proper diffusion of the drug. However, with the use of 1.5 per cent metycaine solution, as advocated by Hingson and Edwards,<sup>4</sup> it has been possible to produce a greater upward diffusion of the anesthetic fluid and thus produce a higher level of anesthesia. By this means, an epidural anesthesia is produced through the caudal canal.

Difficulties in securing effective caudal anesthesia are due to anatomical variations of the sacrum, which is composed of the union of the sacral vertebra. It is a cuneiform bone, flattened, with a marked anterior concavity. Inferiorly it unites with the coccyx. Vertically on both sides, about 2 cm. from the midline, are four or five sacral openings through which run the anterior branches of the sacral nerves. The sacrum posteriorly is convex, especially in the vertical axis. It presents many prominences, the last of which represents the upper limit of the sacral hiatus. The posterior surface of the sacrum is therefore the part that is important to the anesthetist in initiating caudal anesthesia.

The sacral hiatus is limited below by two sacral horns (Fig. 1A) which point downward to meet the horns of the coccyx. Above, the hiatus is limited by the spinal processes of the last sacral vertebra. This has the shape of an inverted v.

The contents of the sacral canal are connective and adipose tissues rich in blood supply and sacral nerve roots which are covered by dura and spinal ganglia.

supplying the pelvic organs and the perineal structures has been fully described by Hingson and Edwards<sup>4</sup> and Lahman and Meitus.<sup>5</sup> They state that painless, uneventful labor has progressed satisfactorily in patients with lesions in the spinal cord or injuries to the cord. Experimentally, such painless labor has been produced in laboratory animals.

Caudal block serves to anesthetize the sacral nerves and abolishes all the pain impulses to the uterus, cervix, vagina, and perineum; but does not affect the rhythmic uterine contractions characteristic of normal labor.

We have used continuous caudal anesthesia since February, 1943, in 250 cases, according to the method described by Hingson and Edwards.<sup>4</sup> We found that the best position is the left lateral or Sims position, as shown in Figure 3. The buttocks are placed at the edge of the bed and the right thigh is flexed on the abdomen and the right leg is flexed on the thigh. The left lower extremity is held in extension. This posture makes for an easier approach to the sacral hiatus as indicated in Figure 3.

The sacral hiatus is best located by first palpating the tip of the coccyx which lies deep in the anal fold. About one and one-half inches above the tip of the coccyx, one can feel a small depression, which is limited laterally by two horns of the sacrum. This depression is the sacral

hiatus through which the needle is inserted. (Fig. 1A.)

A small wheal with 1 per cent novocaine solution is made slightly distal to the depression. Then using a fine intramuscular needle (No. 19 gauge), a little more of the same anesthetic solution is injected into the subcutaneous tissue and the sacrococcygeal ligament (Fig. 1B), which is the laminal closure of the sacral hiatus. A five minute wait is necessary for this area to be sufficiently anesthetized. The flexible No. 19 gauge needle as described by Hingson and Edwards<sup>4</sup> is first introduced perpendicular to the skin. It traverses the skin, subcutaneous tissue and then pierces the sacrococcygeal ligament into the sacral hiatus. The distal end of the needle is then tilted so as to lie, more or less, parallel to the sacral plane and the needle is pushed in further into the sacral canal, usually through its entire extent. The needle, when inserted properly, should feel firm and not easily dislodged from its fibrous tissue entrance.

With needle *in situ*, the stilet is withdrawn. One observes then whether spinal fluid or blood appears. If spinal fluid appears, the needle should be withdrawn and this form of anesthesia should not be attempted. If blood is observed, the needle should be readjusted by withdrawing it slightly and deflecting the needle downward away from the blood plexuses located on the anterior wall of the sacrum. The anesthetic fluid may then be injected.

The initial dose of 30 cc. of 1.5 per cent metycaine solution is given in divided doses of 8 cc., 10 cc., and 12 cc. at about five to eight minute intervals, depending upon the rapidity of appearance of anesthesia. Before giving each of these injections, one should withdraw the plunger of the syringe to make certain there is no entrance of anesthetic fluid into a vein. The anesthetic fluid should be injected slowly and should enter the canal freely. During the injection, the palm of one hand is held over the sacral area exerting slight pressure. This is done to detect the possibility of subcutaneous

infiltration should the needle have been incorrectly inserted.

When the needle has been inserted prop-

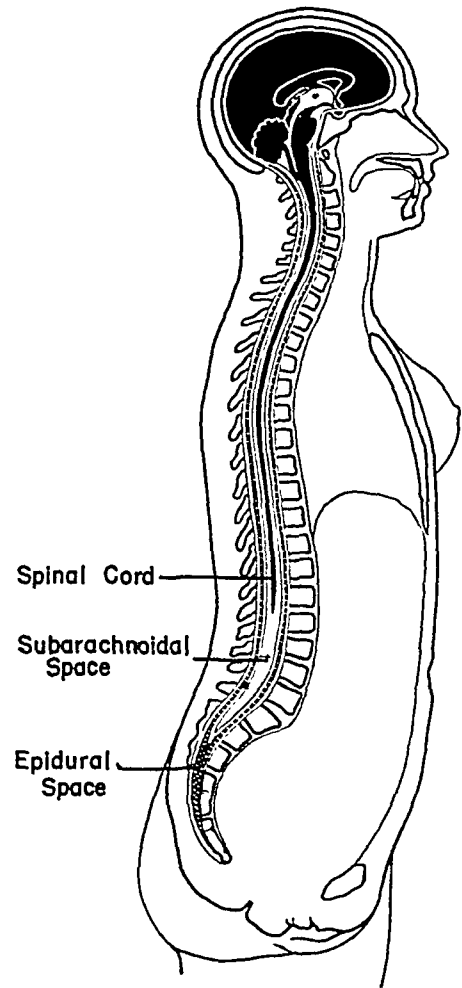


FIG. 2. Schematic drawing showing the extent of subarachnoid space (white) and epidural space (dotted).

erly, anesthesia begins to appear in five to eight minutes after the first injection of 8 cc. of metycaine. Complete relief of labor pains is noted five minutes after the last injection of 12 cc. The progress of anesthesia is noted to be as follows: (1) The region of the coccyx (coccygeal nerve plexus) appearing in five to eight minutes; (2) region of the rectum (hemorrhoidal nerve plexus) in eight to twelve minutes; (3) region of the perineum (perineal nerve plexus) in twelve to fifteen minutes; (4) the vulva area (pudendal nerve) in fifteen to eighteen minutes; (5) inguinal region (ilio-inguinal nerve) in eighteen to twenty minutes; (6) areas midway between the symphysis and umbilicus (ilio-hypogastric); (7)

area midway between the symphysis and umbilicus to the umbilicus (eleventh and twelfth thoracic nerve).

soundly are the ones who have had one or more disturbed nights before active labor began.

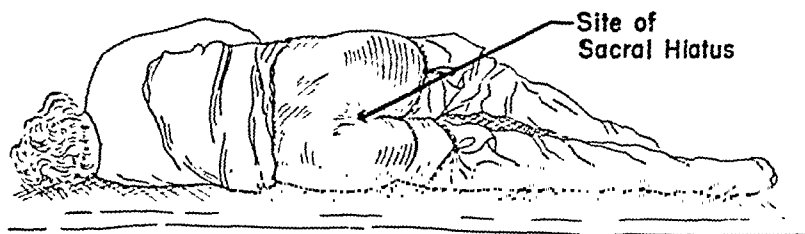


FIG. 3. Position of patient for insertion of needle.

The signs that the anesthetic fluid is properly injected into the epidural space of the sacral canal are: (1) The ease with which the fluid enters the sacral canal. (2) pain in leg (usually left) when fluid is being injected. This is known as the "sciatic sign" which is not always elicited. But, when it is present, one can be certain that the solution is entering the sacral canal; (3) marked relaxation of the anal sphincter permitting the introduction of two fingers with ease; (4) the feet and legs, after ten minutes, become warm, pink and dry. This is due to the paralysis of the vasoconstrictor fibers of the sympathetic nerves.

The continuous caudal apparatus as described by Hingson and Edwards<sup>1</sup> is attached to the needle only after one is assured that it is properly inserted and anesthesia is taking effect progressively from the coccygeal area up to the umbilicus. In order to secure complete relief of labor pains, the level of anesthesia should be maintained up to the level of the umbilicus. When anesthesia goes below this level, an additional injection of 20 cc. of 1.5 per cent metycaine is to be given through the attached continuous caudal apparatus. As a rule, these injections are necessary every thirty-five to forty-five minutes.

With the relief of labor pains, the patient is relaxed and at ease. The only sign of continuing labor is when a hand on the abdomen feels the uterine contractions of the same frequency and intensity as before the administration of the anesthetic fluid. The parturient often dozes off into sound sleep and is able to take nourishment throughout her labor. Those who sleep

Mild toxic symptoms due to the anesthetic were noted in about less than 5 per cent of the patients. These patients were slightly nauseous, dizzy and at times, vomited. Aside from these mentioned discomforts, our patients had no untoward immediate symptoms from the administration of continuous caudal anesthesia and were completely free from pain. Several patients had mild circulatory disturbances which will be discussed later.

Additional injections of the anesthetic are repeated at intervals as stated above when the level of anesthesia falls much below the level of the umbilicus, or when the patient becomes aware of returning pains. The patient may be permitted to lie on either side or on her back, which ever position gives her most comfort.

Rectal examinations are done at intervals to follow the progress of labor. When the patient is fully dilated and the presenting part is low enough for delivery, or the patient has been fully dilated for a sufficient time without progress, labor should be terminated. An additional 20 cc. of anesthetic is then injected into the caudal canal and the needle is removed. The patient is then placed on the delivery table and prepared for delivery. The entire delivery is usually completed within the anesthesia time limit of the last injection, which is about forty-five minutes.

This procedure of removing the needle immediately prior to placing the patient on the delivery table is, of course, optional. Others transport the patient to the delivery table with the needle *in situ* and the apparatus attached. They do this, apparently,

to make certain of anesthesia should the delivery take longer than forty-five minutes. It has been our experience that the forty-five minutes is ample time to complete any pelvic delivery.

The amount of anesthetic fluid used for the entire labor and to complete the delivery varied. The lowest amount used was 30 cc. and the highest amount was 330 cc., the average being 120 cc.

#### FINDINGS IN 250 CASES

We wish to report our experience and observation in 250 patients delivered under continuous caudal anesthesia. There were 239 patients delivered by the pelvic route and the remaining eleven were delivered by cesarean section. Of the 239 pelvic route deliveries, 191 were primipara and forty-nine were multipara. Our criteria for suitability of the use of this form of anesthesia were regular uterine contractions, recurring every three to five minutes, the cervix at least 3 to 4 cm. dilated and effaced, and presenting part engaged or engageable.

The average first stage in the multipara lasted one and three-fourth hours and in the primipara three and one-half hours. The longest first stage in multipara was five and one-half hours and in primipara it was fifteen hours. The shortest first stage in multipara was twenty minutes and the shortest first stage in primipara was thirty minutes.

We consider among these 239 cases, 232 successful and seven failures. A case was deemed successful if after completion of the three initial injections, totaling 30 cc. of 1.5 per cent metycaine, the perception of pain disappeared. Also, that at the same time, uterine contractions continued at the same frequency and intensity as before the administration of the anesthetic. The anesthesia was further considered to be successful, when delivery could be effected under continuous caudal anesthesia without being supplemented by any other form of anesthesia.

A case was considered a failure when it did not meet all the above criteria. Among

the seven failures, four went to full dilatation without pain under continuous caudal anesthesia, but at this point, the needle became dislodged and re-insertion was difficult. These four cases were partial successes in as much as during the first stage and part of the second stage, the patient was free from pain. These deliveries were completed with gas oxygen anesthesia. The other three failures were considered total failures because although the needle appeared to be properly inserted in the caudal canal and the anesthetic fluid entered with apparent ease, the perception of pain did

TABLE I  
METHOD OF DELIVERY

Method	Primipara	Multipara	Success	Failure
Spontaneous.....	2	10	11	1
Low forceps.....	159	32	188	3
Midforceps.....	4	1	4	1
Manual rotation and midforceps.....	16	6	21	1
Forceps rotation.....	8	0	8	0
Breech extraction.....	1	0	0	1
Version (2nd of twin)...	1	0	1	0
Cesarean section.....	8	3	10	1
Total*.....	199	52	243	8

\* One case of twins.

not cease and the needle had to be withdrawn and this form of anesthesia discontinued. In two of these cases, infiltration of the skin was later detected. In another case, no adequate explanation can be offered. There are six additional cases, not included in this study, in which an attempt to enter the sacral hiatus failed. Obesity and general distortion of the usual anatomic landmarks might be a cause of inability to enter the hiatus.

Table I reveals further that twelve spontaneous deliveries occurred under this form of anesthesia. The remaining number were delivered by forceps. The high incidence of forceps deliveries can be explained by the fact that although the patient is conscious and willing to co-operate, the bearing down sensation is completely absent. Despite regular frequent uterine contractions, she



is unable to make use of her auxiliary expulsive powers. The second stage of labor may therefore be said to be delayed unless terminated by operative procedure, an experience common in all cases in which some form of obstetrical analgesia is used. Precipitate labor has not occurred and is very rare under this form of anesthesia.

labor; and this stage is completed in better than average time without the assistance of any oxytocic drugs. Soon after the delivery, there is practically no bleeding from the uterus. There were no retained placentas in this group and there was no instance of immediate postpartum hemorrhage, either during or after the com-

TABLE II  
TIME FOR COMPLETION OF FIRST STAGE OF LABOR

Time	Hours															Lowest	Highest	Average	
	0-½	½-1	1	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	10-11	11-12	12				15
Primipara...	1	2	7	37	46	45	17	8	8	4	5	1	1	2	1	2	30 minutes	15 hours	3½ hours
Multipara...	3	5	13	10	8	2	4	1	.	.	.	.	.	.	.	.	20 minutes	5½ hours	1¾ hours

Correction of occipitoposterior positions by manual or forceps rotation occurred thirty times. With the cervix fully dilated, effaced and retracted over the head, a right or left occipitoposterior is easily rotated to an anterior position, and delivery is accomplished by forceps. Similarly, Kiejlund forceps rotation and Scanzoni maneuver were done to correct posterior positions on eight occasions.

In this series, we managed one case of twins in a primipara. The first baby, weighing 5 pounds 6 ounces, was delivered by low forceps. The second baby, was delivered by version and breech extraction ten minutes after the birth of the first. This baby weighed 6 pounds 7 ounces. The version was performed without undue difficulty, but the maneuver had to be accomplished between uterine contractions with the hand in the uterus all the time.

One breech presentation was managed with continuous caudal anesthesia. When the patient reached full dilatation, progress was slowed and the needle became dislodged and re-insertion was not successful. The delivery was accomplished under supplementary inhalation anesthesia.

There is a remarkable diminution in loss of blood during the third stage of

pletion of the third stage. The placenta was separated and expressed within five minutes in twenty-eight patients. In one instance, it did not separate for twenty-five minutes. The average duration of the third stage under continuous caudal anesthesia was eleven and one-half minutes. The uterus was firm after the third stage was completed and remained so for the entire puerperium. In only one patient, relaxation of the uterus with accumulation of clots was noted when the patient had already been transferred to her bed two hours after the delivery. After the clots were expressed, she presented mild symptoms of shock, undoubtedly due to the loss of blood. Instant treatment with infusion of glucose and saline and plasma, restored her to normal. As a rule, during the puerperium, involution progressed satisfactorily.

The repair of episiotomy or additional lacerations was carried out under the same anesthesia. We noted more bleeding from the pelvic floor lacerations and episiotomies. This is due to the vasodilatation of the perineal vessels generally common in caudal block. The repair is easily accomplished without much hurry which often becomes necessary under a

general anesthetic. There is no marked distortion of parts or uncertainty of anesthesia, as when the perineum is infiltrated locally.

TABLE III  
DURATION OF THIRD STAGE

Time	Number of Patients	Retained Placenta	Immediate P.P.H.
5 minutes.....	28	0	0
5 to 10 minutes.....	38	0	0
10 minutes.....	106	0	0
10 to 15 minutes.....	2	0	0
15 minutes.....	47	0	0
20 minutes.....	11	0	0
25 minutes.....	1	0	0
Total*.....	233	0	0

\* Eleven cesarean sections and six complete failures not included.

Cesarean section was done eleven times under continuous caudal anesthesia. Three were repeat sections; one patient was suffering from rheumatic heart disease; one, from toxemia of pregnancy; the other six patients had cesarean sections performed for cephalopelvic disproportion. Of the last group, two patients had had trial labor for eight to ten hours under this method of anesthesia. When no progress occurred in descent, after that period of time, the patients were prepared for operation and with the needle *in situ*, they were transferred to the operating room. In all cases, there was complete abdominal relaxation. The infant was extracted with ease and removal of the placenta was accomplished without difficulty. The uterus was firm and well contracted during and after the operation and there was a minimum amount of blood loss. There was no drop in blood pressure and the patients had no nausea or vomiting during the entire operative procedure. Postoperative convalescence was smooth and uneventful. One of these patients needed supplemental gas oxygen anesthesia during the operation because the level of anesthesia was not high enough.

All sections were of the low cervical type with transverse incision into the uterus.

There were no maternal mortalities or near deaths as reported by Block and Rochberg.<sup>6</sup> However, five instances of mild circulatory collapse as described by Siever and Mousel<sup>7</sup> were noted. These patients appeared pale, listless, apathetic, nauseous, with noticeable shaking of upper extremities, head and trunk. There was a considerable drop in blood pressure (30 to 40 mm.). This condition was noted as a rule close to the delivery or early in the postpartum period and continued for a short period of time, not longer than ten hours. No particular therapy was instituted but external heat, forcing of fluids and sedation were generally sufficient to restore them. On two occasions, administration of caudal anesthesia resulted in apprehensiveness, restlessness, and increased pulse rate in the mother and a concomittant increase in the fetal heart sounds. Both of these patients improved immediately when glucose was administered intravenously and 1 cc. of adrenalin (1-1000) was given subcutaneously. In our later cases we followed the suggestion of Block and Rotstein<sup>8</sup> and we added ephedrine to the metycaine solution. We had subsequently found fewer instances of circulatory disturbances. Aside from the incidents mentioned above, there were no maternal morbidities that could in any way be associated directly or indirectly with the administration and use of continuous caudal anesthesia.

All newborns cried spontaneously on delivery and none required the use of artificial methods of resuscitation. There were two still-births in this series. Both were due directly to traumatic forceps deliveries. One case was misjudged as to the cephalopelvic adequacy. The head entered the pelvis but was arrested at the spines, and after much difficulty and several applications of forceps, a still-born, severely traumatized, fetus was delivered. Another still-birth occurred in an elderly primipara who displayed evidence of apprehension,

rapid pulse and accelerated fetal heart tones soon after the administration of continuous caudal anesthesia. When she was ready for delivery several hours later, both the patient's condition and the fetal heart sounds were much improved and considered normal. Attempts at forceps extraction failed. Other attempts at forceps extraction following manual rotation for the correction of an undiagnosed occipitoposterior position also failed. An internal podalic version was finally done and a still-born fetus was delivered. This last procedure was done under gas oxygen ether anesthesia because the continuous caudal anesthesia had, by that time, worn off.

One neonatal death occurred after an easy low forceps delivery in a primipara nine hours in labor and under continuous caudal anesthesia for four and one-half hours. The child was cyanotic, had difficulty in breathing, breathed irregularly and expired during the first twenty-four hours. Postmortem examination revealed atelectasis of the lungs and no evidence of intracranial damage. There was a neonatal morbidity in an immature newborn, which early in its neonatal life developed evidence of cerebral trauma. The baby subsequently improved and was discharged on the fourteenth neonatal day.

In spite of the great preponderance of forceps deliveries, (over 94 per cent), we found the average loss of blood as determined by clinical observation to be considerably less than with other forms of anesthesia. The uterus is well contracted and firm. In fact, the usual dose of pituitrin or ergotrate routinely used can very well be dispensed with.

As the anesthesia wears off, the patient is conscious of pain in the lower abdomen and perineum. This pain is relatively exaggerated; for the sudden transition from a painless labor and delivery, to even moderate pain, causes the patient much discomfort and apprehension. We have, therefore, administered to most

patients, morphine sulfate gr.  $\frac{1}{4}$  soon after delivery.

In our series of 250 cases, a small percentage had either retention of urine after delivery or difficulty in voiding. In such cases, one or two catheterizations became necessary. The reason for such retention is probably atonicity of the bladder. We are conscious of the fact, however, that after operative or even spontaneous deliveries, a certain percentage of parturients will have bladder difficulties. Our percentage of urinary disturbances, therefore, cannot be considered as a complication, certainly not to the extent of considering it as a contraindication to continuous caudal anesthesia.

Low back pain was a frequent complaint of many of the patients. This varied in degree from a mild pain over the site of injection, which disappeared in twenty-four hours, to quite severe pain which lasted several days. The latter was the exception, not the rule. Heat applied to the site of the painful area seemed to relieve those of the more severe type. Patients are able to move about freely soon after delivery and are encouraged to do so. Intake of liquids and other food can be commenced at once.

The involution of the uterus and character and amount of the lochia has not differed in any respect than heretofore without this form of anesthesia. The episiotomies healed in the normal fashion and we did not note any difference in the healing or discomfort in that area. Painful and edematous hemorrhoids were not as frequent as in deliveries with other types of anesthesia. This is explained by the absence of bearing down during labor and the marked rectal relaxation under continuous caudal anesthesia.

The entire postpartum course, otherwise, differed in no way other than the usual. The patients lie on their abdomen on the fifth day, sit up in bed on the seventh and are out of bed on the eighth day. They are discharged from the hospital on the ninth day postpartum.

## SUMMARY

1. Relief of pain during labor and delivery is now recognized to be a "must" in modern obstetrics.

2. Continuous caudal anesthesia in obstetrics was used in a series of 250 patients, 239 pelvic deliveries and eleven cesarean sections.

3. Cervical dilatation is markedly facilitated, thereby shortening the first stage of labor.

4. The entire labor and delivery can be accomplished under one form of anesthesia.

5. In general, there were no untoward effects upon the mother. However, a few instances of mild circulatory disturbances were noted and easily combatted.

6. The results upon the fetus were good. The causes for the still-births and the neonatal morbidities do not appear to be due to this form of anesthesia.

7. There was a definite diminution in blood loss.

8. Operative procedures are greatly facilitated, due to the relaxed pelvic parts.

9. Inhalation anesthesia to terminate labor with its resultant dangers and complications is avoided.

10. The postpartum course does not differ in any respect from any other form of delivery.

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# CULDOSCOPY\*

## A NEW METHOD IN THE DIAGNOSIS OF PELVIC DISEASE—PRELIMINARY REPORT

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ENDOSCOPY as a diagnostic procedure is now being utilized frequently in all departments of medicine. The direct view of the gross pathology in various hollow viscera, as revealed by the endoscope, is of distinct diagnostic value. The instrument enables one to remove tissue for biopsy from these organs and also to photograph their interior. The bronchoscope, the gastroscope and the cystoscope, when competently applied, have proved their value.

The peritonescope has many advocates who ascribe definite advantages to its use in the diagnosis of intra-abdominal and pelvic conditions. Ruddock's<sup>1</sup> statistical analysis of 900 cases established the value and safety of the procedure. More recently Belings<sup>2</sup> has pointed out the indications for the use of the procedure and emphasized the importance of the instrument on determining the presence or absence of liver metastasis and hepatic cirrhosis. Meigs<sup>3</sup> emphasized the importance of the peritonescope in the differential diagnosis of suspected pelvic growths. Hope<sup>4</sup> reported ten cases of unruptured ectopic gestation diagnosed by the peritonescope.

One of us (A. D.) has used the peritonescope as an aid in the diagnosis of upper abdominal and pelvic disease. The instrument was used in cases of suspected gall-bladder and hepatic disease and pelvic conditions such as, small ovarian disease, tubal occlusion, endometriosis, and suspected ectopic pregnancy. The procedure was reserved for those cases in which the

usual methods of diagnosis gave inconclusive results and the diagnosis was a matter of conjecture. The route to the pelvis by abdominal puncture with the aid of vaginal manipulation and various postures did not give uniformly satisfactory results. The failure of proper visualization was usually due to the presence of intestinal loops and the inability to isolate the pelvic organs properly.

Efforts to improve the usefulness of the instrument in pelvic diagnosis has led to the adoption of the vaginal route to view the pelvic organs. This procedure we have termed culdoscopy. It gives uniformly good results and has led to the adoption of other new diagnostic procedures such as, the dye test for tubal patency. When the procedure is carried out as described in properly selected cases, one can obtain all the visual and some of the palpable information that is otherwise obtained only by laparotomy.

In cases of sterility very definite information can be obtained concerning the condition of the Fallopian tubes and the ovaries. When tubal occlusion is present, the character and location of the obstruction can often be viewed. The location and size of the aperture in the partly occluded fimbriated end of the tube is visible. The ovaries can be examined minutely and the size and presence of follicle, corpora lutea and small cysts can be observed. Small areas of endometriosis are plainly visible and the degree of pelvic and intestinal adhesions can be determined.

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# THE INSTRUMENT AND DESCRIPTION OF THE PROCEDURE

The instrument consists of a culdoscope, as illustrated. A trochar and cannula has been especially designed to facilitate punc-

straps are used to support the patient in the knee-chest position. When properly applied the patient can maintain this position for as long as one and one-half hours without distress.

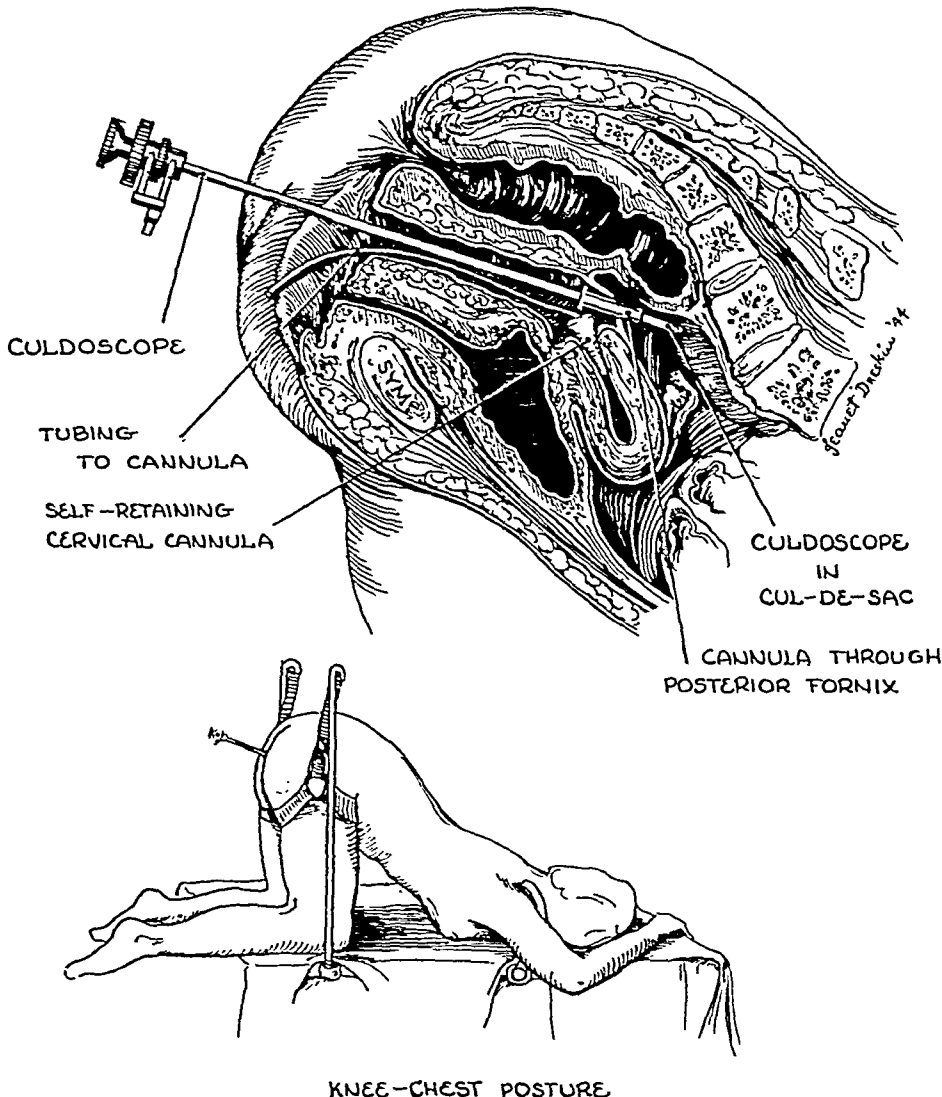


FIG. 1. The culdoscope is shown in the cul-de-sac and the screw tip cervical cannula is in the cervical canal. The lower figure illustrates the proper method to maintain the knee-chest posture.

ture of the cul-de-sac. A modified Colvin type of self-retaining cervical cannula with detachable tubing is essential. A perineal retractor or Sim's speculum is necessary. Other parts of the equipment include a 20 cc. syringe, a curved volsellum and thigh straps.

The examination is made in the knee-chest position as no other posture gives satisfactory results. Well fitted shoulder braces, upright leg holders and thigh

*Anesthesia.* Caudal anesthesia with 30 cc. of 1 per cent metycaine gives excellent results and allows for many intrapelvic manipulations and procedures. Local infiltration of the vaginal vault with 10 cc. of 1 per cent novacaine will usually suffice.

The infiltration of 30 cc. of 1 per cent novocaine in the region of the presacral nerve by the pararectal route has given satisfactory results together with local infiltration at the point of puncture of the

vaginal vault. When caudal anesthesia is used, the patient is placed in the knee-chest position after the anesthesia has been injected.



FIG. 2. Self-retaining screw tips for the cervical cannula.

*Procedure.* The perineum is elevated slightly with the Sim's speculum. The cervix is grasped with the curved volsellum and drawn down. The vaginal vault is infiltrated with 10 cc. of 1 per cent novo-

comes into view readily. The instrument is directed toward the right side and the right tube and ovary are brought into view and their position and condition observed. The presence of cysts, clubbing or inversion of the fimbria are readily discernible. The instrument is then rotated to the left side and similar observations are made of the left tube and ovary. Further rotation of the instrument brings the uterosacral and the rectosigmoid region into view and observation at the brim of the pelvis reveals the iliac vessels, the infundibulopelvic ligament and ovarian vessels and above the brim loops of the small intestines are seen and occasionally the appendix.

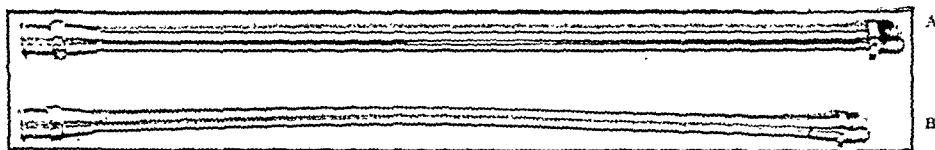


FIG. 3. A, rigid cannula for the screw tips; B, flexible cannula for the screw tips.

caine at the point where it leaves the posterior surface of the cervix.

The self-retaining cervical cannula is then screwed into the cervix and the flexible tubing attached. The trochar and cannula are then poised at the point in the vaginal vault where the posterior vaginal wall leaves the cervix. The point of the trochar is directed slightly downward toward the central point of the pelvis. The trochar is thrust through the vault of the vaginal. Entrance into the cul-de-sac is attested by the sound of inrushing air on removing the trochar. The cannula is left in place and the culdoscope is inserted into the pelvic cavity and the contents of the pelvis viewed.

The Fallopian tubes, ovaries, anterior and posterior surfaces of the uterus, sigmoid, rectum, broad ligaments, uterosacral ligaments, promontory of the sacrum, loops of the small bowel, and in some instance the appendix are plainly visible.

In the visualization of the pelvic structures the posterior surface of the uterus

The cervix may now be manipulated and the anterior surface of the uterus and partially distended bladder can be observed. When a diluted solution of Indigo carmine (5 drops to 50 cc. of saline) is injected through the cervix by means of the self-retaining cannula, the dye can be seen to distend the tube. Patency is established when the dye exudes from the fimbriated end of the tubes. Any clubbing of the fimbriated end is well viewed. The thickness of the tube and of the clubbed end can be estimated by the amount of color transmitted through the wall.

When the examination is completed the culdoscope is removed and the cannula left in place. A bolster is placed under the abdomen and the thigh straps and shoulder braces are released. The patient is placed on her abdomen over the bolster and the abdominal air expelled. The cannula is then removed. This procedure reduces to a minimum the shoulder pains that result from the presence of air in the upper abdomen.

When one becomes familiar with the procedure, many manipulations such as rupture of small cysts, biopsy of the

All patients examined to date have been admitted to the hospital overnight. After one has become familiar with the technic



FIG. 4. Trochar and cannula for puncturing the posterior vaginal wall.

ovaries or tumors can be readily performed. This procedure isolates the tubes from the other pelvic viscera and makes them available for coagulation or ligation as a method of sterilization.

*Indications for Examination.* The indications are: (1) Primary and secondary sterility in which the usual examinations do not give all the information desired; (2) small ovarian disease in which vaginal

it is believed that in properly selected cases the procedure can be utilized at the office or clinic.

Our experience in over forty cases of culdoscopic examination has brought the authors to the conclusion that this examination is an invaluable asset in the study of obscure pelvic disorders. The procedure gives definite and detailed information concerning the pelvic organs that is not

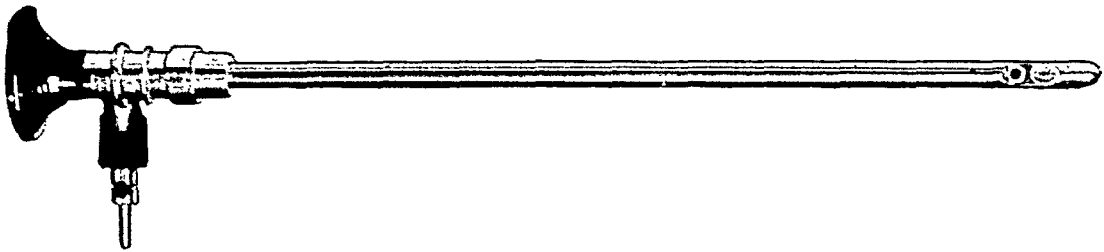


FIG. 5. The Decker culdoscope.

palpation is inconclusive; (3) differential diagnosis of ruptured follicle or corpus luteum cysts from ruptured ectopic pregnancy; (4) suspected unruptured ectopic gestation; (5) study and effect of the gonadatropins upon the ovary, and (6) endometriosis.

*Contraindications for Examination.* These are: (1) Adherent uterine retrodisplacement with fixed masses in the cul-de-sac; (2) so-called frozen pelvis; (3) acute and subacute pelvic inflammatory disease; (4) cardiac decompensation in which the assumption of the knee-chest position is unsafe, and (5) when puncture of the cul-de-sac in the knee-chest position does not result in an inrush of air.

obtainable by any other procedure but laparotomy. The procedure is safe; no mortality or complications have been observed to date.

Culdoscopy has many advantages over the abdominal approach. The examination made by way of the cul-de-sac is less painful and the visualization is complete. Other tests can be performed at the same time without changing the posture of the patient, such as tests for tubal patency by the injection of fluid through the cervix. The psychic aversion to abdominal puncture is avoided. We have found that patients readily submit to the examination and to repeated examinations.



## SUMMARY

A new procedure for pelvic visualization termed culdoscopy is described.

Culdoscopy is found superior to peritonoscopy in the diagnosis of pelvic disease and the study of physiology.

The procedure is invaluable in the investigation of pelvic tumors, small ovarian disease, endometriosis, ectopic pregnancy

and especially helpful in the detailed study of primary and secondary sterility in females.

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Cysts of the breast are usually due to blockage of the secreting mechanism, either by fibrosis from without or obstruction from within the lumen.

From "A Short Practice of Surgery," by Hamilton Bailey and R. J. McNeill Love (H. K. Lewis & Co. Ltd.).

# PELVIC REACTIONS TO INFECTIONS

## A STUDY OF 493 OPERATIVE CASES

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THESE 493 patients were operated upon in our Cook County Hospital Clinic during a period in which the conservative treatment, having had its incipency, came into more general use. The results obtained in this series of cases went far to establish the fact that most reactions to infections could be depended upon to overcome the infection, but that the reactions, even though the infections had subsided, left adhesions, thickened tissues, masses large and small, which produced pain and interfered with the function of organs, and were often the site of returning activity by reason of dormant foci or reinfections, so that in the interest of health, operation became necessary.

It should be understood, also, that many cases were so related to sources of infection that a quiet period never resulted in the entire absence of activity.

We must not consider the reactions as primarily an enemy of the host, for they represent the forces by which the infection is overcome, after which they remain as health-destroying structures and may lead to fatal results. Usually, however, such results are connected with reinfections.

Perhaps this clinical material will have added value if we visualize the conditions under which they come. This is a charity clinic which receives women of all ages, colors and nationalities. It goes without saying that the majority are poor and many have always been destitute; many have seen better days; some in fair circumstances come because they do not feel able to stand the expense of a long sickness; some come to beat the County, and some come thinking that there they meet better

specialized care than they could select outside; but most important, many come because their present condition demands and is driving them to seek hospital care. Only a moderate number come because they elect an operation and are ready for it. Most of these patients then have come at the height of an attack, or because a moderate attack has furnished an urge to remember previous attacks.

It is probable that no like sized group of cases show the average of severity and complications, except in a like charity clinic. Very few come presenting conditions ready for operation. Patients that come with normal or very slight temperature, who need only a few days to get the field of operation clean, and heart, bowels and kidneys functioning well, are rather the exception, and represent more the general run of private cases. The more usual run come with active conditions requiring one week to ten days to reach a normal temperature and relieve disturbances of circulation, and to get the bowels and kidneys functioning well. Deflation of all distended structures is required. There is a large, but lesser number, who come with conditions so active and so neglected that two to three weeks are required to reach conditions which make them safe risks.

A moderate number come in which a preliminary cul-de-sac drainage is necessary to save life and prepare for a clean-up operation. A few come with pus pockets and foci of infection so numerous and sepsis so severe, that after a long effort at preparation, the risk has to be taken to bring to an end a dangerous activity; lastly, some patients, reaching a quiet

period, have become so reduced in strength that they should have a long period of recuperation and rebuilding before being subjected to so severe an operation as their condition requires. Rest, fluids, plasma, transfusions and tonics are desirable over a long period. Not only will these patients stand an operation better because of this long period of rest, but the local tissues will have improved so as to make the operation a lesser attack upon the vital forces of the patient.

A typical picture in extreme cases upon entrance is: a patient very sick, anorexia, vomiting, marked distention, lack of bowel action, bladder disturbances and abdominal distress directed toward the lower abdomen; temperature  $102^{\circ}$  to  $104^{\circ}\text{F.}$ ; pulse 100 to 140; pus exuding from vagina, scalded vaginal mucosa, uterus fixed or uterus and greatly enlarged adnexia "frozen," all appearing as one mass, fixed to bony pelvis and in many cases including the lower abdominal wall. Such a mass chokes the bladder, the rectum, and involves the sigmoid and loops of small bowels; the ureters are choked and the urinary stream is compressed, embarrassing kidney function, and the circulation of all organs is hampered. Marked tenderness is present and one structure cannot well be distinguished from another. All degrees of involvement are encountered from this, upward to severe bowel ileus and general peritoneal infection, infection of the blood stream, local and distant pus deposits down to very moderate tubal involvements in an inactive stage.

The so-called "hot" cases were once thought to require immediate operation and so furnished a large part of the mortality and morbidity following surgical treatment of this class of cases. It has now been proved that most of these cases may be guided through the active stage and brought to a safe surgical period. It will be seen then that to attain a low surgical mortality, an important preliminary treatment must be carried out.

These results must be attained: the bowels, kidneys, bladder, ureters and circulation should function well. Tenderness and swelling should largely disappear. The abdomen should become flat. The pelvic "frozen" mass should present to a certain extent its component parts. The temperature should reach and maintain a normal level—in mild cases four to five days, in moderate cases one to two weeks, and in severe cases a longer time. The pulse should approach normal; the leucocyte count should be as low as 10,000.

We have not derived much help from the sedimentation test in determining the best time for operation. All patients in preparation for an operation should remain in bed. Getting up and around at the first evidence of improvement brings about an exacerbation of symptoms, delays the period of safe operation, prolongs the stay in the hospital, and defeats the purpose of rest and preparatory treatment.

The preparatory treatment should include sedative enough to quiet pain and induce sleep and the lessening of tension with hot douches and hot stupes. Bowel activity may be encouraged by mild enemas; cathartics should be avoided. The Levine tube is very helpful. At times good results are gotten with the Miller-Abbott tube. Fluids may be given intravenously until tolerated by the intestinal tract to flush the kidneys and to counteract acidosis. This line of treatment usually results in a marked drop in the temperature, pulse and respiration curves, and in a return of feeling of well being. The choked condition of the pelvis disappears and not only the patient, but the local tissues, are in better condition for operation.

Restlessness and nostalgia lead these patients to a desire for action; they want to have the operation performed or be allowed to go home. If they have the operation too soon, it will show in mortality and morbidity results. If the preparatory treatment is delayed too long, they will go home in many cases. If they would go home, live quietly and return at the proper

time, this would often be desirable, but these patients are not governed by judgment and they would return only when another acute attack has overtaken them. This means that in many cases the picking a time of a fairly safe operation before they are quite improved enough to take up their duties at home is important. It is apparent that patients entering the hospital in an active stage of infection will not be bacteria-free when they reach a quiet stage, and this is well shown by the

having a primary attack without masses have been referred home for possible recovery. This has been followed by a large percentage of returns. At present better results might be obtained with free use of sulfonamides.

*Race.* In commenting on the etiological factors, although 58.4 per cent of the women were white in this series, it may be said that pelvic infections whether venereal, puerperal or other type, reveal no racial preference.

TABLE I  
STATISTICS OF 493 OPERATIVE PATIENTS

Race	No.	Age in Years	No.	Civil State	Pregnancies (Full Term)	Puerperal Fever	Abortions
White.....	288	15-20	112	Married 333	0-267	10	152
		21-25	173	.....	1-131		
		26-30	103	Single 90	II- 40		
Black.....	205	31-35	54	.....	III- 27		
		36-40	38	Widow 70	IV- 14		
		41-45	6	.....	V- 5		
		46-50	6	.....	VI- 2		
		57	1	.....	VII- 2		
					VIII- 2		
					IX- 2		
					XI- 1		

study which was made by Dr. Lash. Rather must we assume that the bacteria have become dormant and are for the time being controlled by the immunity which has developed in the patient.

While further improvement might be desired, the patients' interests are not best served by their going home to another attack, and should not be risked if they present a fairly good condition for operation.

Following a consideration and analysis of the 493 cases, we will detail a plan of attack for the severe ones, that will simplify matters for the operator and be life-saving for the patient.

An analysis of the histories of the 493 patients gives the statistics shown in Table I. Acute venereal infections, lacking gross pelvic reactions, were sent in the distribution to the Venereal Clinic. Some borderline patients that seemed to be

*Age.* The range of age was from fifteen to fifty-seven years, with the majority of the patients, 78.7 per cent, being below thirty.

*Civil State.* The fact is that 81.7 per cent were married. Thus pregnancy, abortions, spontaneous or induced, and puerperal infections play an important rôle in the causation of pelvic infections, although venereal infections are not excluded by marriage.

*Obstetrical History.* The incidence of women unable to carry a child to term or become pregnant was high, and as one would expect in such a series, nullipara were in the majority. Also after the first full term pregnancy the occurrence of subsequent ones was uncommon. Thus 26.5 per cent of the patients had one full term pregnancy while only 8.3 per cent had two full term pregnancies, and

the number of women having more than two was even smaller. It is, therefore, observed what an important part pelvic infections played as the cause of sterility, although one must not overlook syphilis.

TABLE II

BACTERIOLOGY OF GROSSLY PATHOLOGICAL FALLOPIAN TUBES IN 100 PATIENTS

Streptococcus.....	38	{ Hemolytic..... 14
		{ Viridans..... 21
		{ Indifferent..... 3
Gonococcus.....	4	
Bacillus coli.....	13	
Staphylococcus.....	33	
Micrococcus tetragenus.....	1	
Bacillus diphtheroids.....	3	
Bacillus proteus.....	3	
Bacillus capsulatus.....	4	
Pneumococcus.....	2	
Cultures in 20, sterile		

**Bacteriology.** The results of the bacteriological study of the grossly pathological Fallopian tubes removed from 100 patients are given in Table II. The streptococcus is the predominating organism, occurring in 38 per cent of the cases, alone or with other organisms, and being of the hemolytic type in 14 per cent. The streptococci were studied especially because of their frequency. Based upon morphological, cultural, biochemical and pathogenic characteristics observed, they were found to be similar to the strains from the different fatal streptococcic infections, as in septicemia and general peritoneal infections. These findings should be borne in mind as they support the principles laid down for treatment.

**Pathology.** Bilateral salpingitis occurred in 249 cases, unilateral in eighty. Both ovaries were involved in ninety-two instances, in one of which there was a complete sclerosis with resulting amenorrhea; in 193 patients only one ovary was involved. There were 110 bilateral pyosalpinges and fifty-one unilateral. In only eight cases was there a pelvic abscess. The associated pathology was as follows: Retrodisplacement ninety, relaxed pelvic floor thirty-seven, cystocele fourteen, rectocele sixteen, old lacerated cervix nineteen, fibroids thirty, erosion of the cervix eight, mucocele of cervix one, metritis

thirty-seven, prolapsed uterus three, Bartholinian cyst three, Bartholinian abscess two, retained placenta of two years standing one, acute epiploitis three, cyst of rectum one, parovarian cyst one, dermoid cyst one, teratoma one, lacerated sphincter ani one, bicornuate uterus one, ruptured ectopic pregnancy one, and cordate pregnant uterus one.

The listing of the pathological conditions can hardly describe the pelvic conditions found at operation: the wide range of involvement, from the thickening and binding down of one tube to the marked state of conglomeration of uterus, large and boggy, of Fallopian tubes, distended with pus and thickened, of ovaries, cyst or abscess containing, of friable rectum, of thickened sigmoid, cecum or small intestine and of omentum, all bound together into a solid mass, the so-called frozen pelvis. The degree of involvement of the peritoneum with healing was remarkable. The ability of the pelvic peritoneum to localize and overcome infections is due to the relative non-activity of the pelvic viscera as compared with those of the abdomen and to the probable immunization of the patient. This quiet state is disturbed at the menses, by work or exercise and pregnancy where possible. Although organisms cannot be found in the blood in the acute stage, immunization is probably actively produced by the toxin from the causative organisms, especially the streptococci. This assumption is based on the probable similarity of streptococci, as those of puerperal fever, scarlet fever and erysipelas have been found to produce toxin. Therefore, the bacteriology and pathology of these infections definitely establish the fact that surgery is not necessary but harmful in the acute stage. However, when the normally mobile organs such as the intestines, omentum and sigmoid are immobilized by adhesions or pus containing tubes or ovaries are present, surgery is demanded after the acute stage has subsided. The tubes and ovaries containing pus may not only be foci of

infection or of chronic toxemia, but also the cause of amyloidosis of the parenchymatous organs.

*Symptomatology.* The clinical course of these pelvic infections is quite characteristic. The general systemic condition depends on the degree of disturbance of digestion and of rest. Locally, pain in one or both iliac fossa was constant occurring in 451 patients. It varied from a dull, aching, annoying discomfort, aggravated by exertion to a sharp, cramping or lancinating pain. The involvement of the intestines and omentum was probably the chief cause of the pain. Backache, though considered common was present in only ninety instances. Leucorrhea was present in almost all cases, although the amount sufficient to attract the patient's attention was proportional to the degree of personal hygiene. It was noted in only 283 patients. Burning on urination was complained of by only seventy-eight. The incidence of menstrual disturbances was as follows: menorrhagia 121, metrorrhagia twenty-one, dysmenorrhea 108, and irregularity in time interval thirty-six. Temperature rarely rose above 103°F. and was more commonly absent. The pulse was usually within normal limits increasing when the process extended or an abscess was present. The leucocyte count ranged from 6,000 to 31,000 but in all cases before operation was below 10,000.

The duration of the symptoms varied from months to years. The usual course consisted of a series of attacks, lasting from a few days to two or three weeks, with irregular intervals between. Of the 493 patients, 204 had one or more previous attacks.

With the characteristic history and findings no difficulty was experienced in diagnosing the condition, but the atypical clinical findings may be confusing. Thus in a unilateral involvement with a menstrual irregularity, ectopic pregnancy may be considered, especially in the unruptured state and only by observation and some-

times only by laparotomy will one be able to differentiate the two. Fibroids of the uterus may be simulated. In the streptococcal infections, especially the postabortive type, a hard fixity of the pelvis may be produced so that carcinoma of the uterus with extension will be so strongly suggested that laparotomy is considered only as a confirmatory measure when the true condition is recognized. Sampson's cysts or endometriomas of the ovaries may also produce pelvic conditions resembling inflammatory processes.

*Treatment.* Before going on to the surgical treatment one may make mention of those that have been offered as substitutes. Cherry has recently reported that foreign protein therapy is of no value. The reaction required to produce a change in the pelvic condition was dangerous to the life of the patient. However, Gellhorn's report cannot be ignored and in certain types of cases palliative results may be obtained. As to diathermy, Cherry found it of value in the gonorrheal infections, but dangerous in the postabortive type, having had one death and one abscess formation resulting from the procedure. The streptococcus being a common primary or secondary invader, diathermy should be considered only with caution if at all. Since the effect of the diathermy is only to decrease the size of the pelvic inflammatory mass and relieve the patient of symptoms, the question arises as to its ability to free the bowels or omentum or to restore the uterus to its normal position. But here again, these non-surgical measures are aimed against the infection and as has been stated before, rest and non-interference will achieve all that is possible, although diathermy with care can be used as a palliative measure. For emphasis, it may be reiterated that surgery is of value not to treat the infection but the permanent reactions to the infection. These end results requiring surgery are intestinal involvement, malposition of the uterus and adnexal masses, all producing symptoms, and are unaffected by medical procedures for any length of time.

The decision having been reached that only surgery can be of aid to the patient, the determination of the proper time for operation is next considered. The condition of the patient that indicates the optimum time for the operation is reached when the acute exacerbation or the acute superimposed infection is localized or healed and immunity has been induced. No better guide have we of judging this desired state than temperature, leucocyte count and degree of tenderness in the iliac fossae. Neither Schmitz nor Cherry found the sedimentation test superior to the methods mentioned. From experience it has been observed that when the temperature and leucocyte count remain within normal bounds for five to seven days the patient is usually ready. But in the puerperal type a wait of several months is preferred if the patient can be controlled; at the Cook County Hospital such ideal circumstances are not present. In the group analyzed the preoperative or preparatory interval varied from one to fifty-one days in the hospital.

The surgical procedure carried out is controlled by the pathological condition present; that is, each patient requires individual consideration. The pathological state should be a greater guide to the gynecologist than the social status of the patient. However, in young women who make up the majority of the patients (78.7 per cent) a conscientious effort must be made to conserve as much ovarian and endometrial tissue as possible. This effort should be made even at the risk of requiring a future operation. It is not because of mere sentimentalism that this is advocated. That women have a more unstable mental balance is common knowledge. The depression and fear of abnormality instilled by the absence of the normal function of menstruating can leave a definite ill effect on a woman, so that all that was gained by preventing physical invalidism is lost by the appearance of mental unsatisfaction.

In the 493 patients, the following necessary operations were performed: salpin-

gectomy, bilateral 418, unilateral seventy-five, cophorectomy, bilateral 134, unilateral 263, partial resection of remaining one, twenty-seven, hysterectomy, abdominal, total forty-three, subtotal sixty-eight, vaginal total one, defundation twenty, amputation of the cervix fifteen, trachelorrhaphy forty, dilatation and curettage fifty-one, round ligament shortening 122, appendectomy 285, repair of ileum five, one of which required resection and anastomosis with the sigmoid; ileostomy one, partial ligation of the omentum two, anterior colporrhaphy twenty-one, perineorrhaphy sixty-three, posterior colpotomy twelve, drainage eighty-two, secondary abdominal suture one; excision of Bartholin's gland four, excision of urethral caruncle one, excision of cervical mucocele one, and repair of sphincter ani one.

The above statistics show that eighty-four per cent of the patients required both tubes to be removed, as conservation was impossible. On the other hand only 27.2 per cent of the patients lost both ovaries, while in 72 per cent some ovarian tissue remained, varying from a part of one to both. The incidence of hysterectomies (all types) was 22.7 per cent and of defundation 4 per cent. Some uteri, while not entirely normal, were allowed to remain as they usually heal after the essential disorder is removed. Only one vaginal hysterectomy was performed. This hardly needs discussion for in the presence of a conglomeration of adherent pelvic and adjoining organs, vaginal hysterectomy has no large field. Drainage was carried out in only 16.6 per cent of the cases, being dependent upon the degree of oozing produced and of exudate found.

The postoperative course was uneventful in 85.6 per cent of the patients, for that number left the hospital before or by the nineteenth day. After this time the number of patients decreased as the postoperative period increased. The longest periods were, one sixty-seven days because of the phlegmosia alba dolens and the second eighty-four days due to an intestino-abdominal

fistula, pulmonary tuberculosis and chronic nephritis.

The morbidity incident to the operations was, pyelitis one, cystitis three, wound infections thirty-five, perineal abscesses one, phlegmosia alba dolens three, intestino-abdominal fistula two, postoperative bronchopneumonia one, and an aggravation of a cardiopathic condition in one case. It is interesting to note that one patient who had a psychosis before operation became normal after it.

Of the 493 patients operated upon, seven died, giving a mortality of 1.42 per cent. The causes of death were as follows: (1) Generalized gangrenous fibrinous peritonitis with perforation of the rectum, death on the fourth postoperative day; (2) postoperative ileus, died on the fourth day; (3) acute dilatation of the stomach, died on the second day, no autopsy; (4) postoperative shock, died ten hours after operation; (5) acute epiglottitis and generalized peritonitis, died on the tenth day; (6) cardiac failure on the tenth day, no postmortem; (7) generalized peritoneal infection and edema of the lungs, died on the twenty-third day postoperatively.

#### PLAN OF OPERATION

The patient should have had a normal temperature for several days in the less complicated cases, to two to three weeks in severe cases, to many weeks in the exceptionally severe cases. There should be a corresponding normalcy of the pulse and leucocyte count, and all vital functions acting well. A dried out condition should be overcome by fluids by mouth, salines and glucose by rectum, and perhaps glucose intravenously. Any considerable anemia may be overcome by preoperative transfusion, which may be required in some cases with long continued sepsis and in cases complicated by fibroids with hemorrhage. Chemotherapy has been found helpful in some cases, preoperatively as well as postoperatively.

In some few cases with moderate reactions to infection involving the uterus and

adnexia, special conditions may make it desirable to choose a vaginal operation, but the large number of cases will be served best by an abdominal operation.

The operator should have a plan. The less experienced the operator, the more necessary the plan. Examination may indicate that the total mass fills the lower part of the abdomen. When the patient was examined upon entering the hospital, this was recognized as a conglomerate mass with individual structures little recognized, but now one structure begins to be differentiated, at least slightly, from another. Bimanual examination may be instructive, but where palpation fails, our sixth sense should penetrate the mass and recognize it as made up of several layers of organized structures, some of which must be left and some of which are to be removed.

1. At the back and sides is the bony pelvis, usually not much affected, although infection may have penetrated the acetabulum, and the sacro-iliac joints may be involved.

2. Lining the pelvis and covering the ureters, blood vessels, muscles and connective tissue, is the peritoneum, which may be little involved or may be penetrated by infections and the protected structures seriously involved.

3. More or less movable structures, but now fixed, are the tubes, ovaries, with perhaps cysts, and the uterus, with perhaps fibroids. Abscesses may be found in any of these structures, or between them and surrounding structures. The tubes and ovaries may be in contact in front of the rectum, or the much involved appendix may lie in the median line between the pus tubes, or the pus tubes may grasp the rectum at the sides, or the pus tubes may encircle the rectum, absorbing the rectal mesentery. The tubes may be adherent in the cul-de-sac or be lifted up and adherent to the uterus, or shoved forward and be adherent to the bladder, the uterus being retroverted and flexed and adherent to the cul-de-sac or rectum. Any structure lying in contact with the tube may become



adherent to it and in time, an exit channel may form through the adherent walls. One tube may burrow the peritoneum so that it contacts the ureter and a uretero tubal fistula may form.

4. A layer of sigmoid, and small bowels, cecum and appendix may become adherent over the uterus and tubes. The bladder may furnish the anterior part of this layer.

5. The omentum may be disposed over the previous layer and become thickened and form a cast-like layer.

6. Outside the above layer and perhaps extensively adherent to it is the abdominal wall, complete in its layers if no previous operation has been done. Perhaps a previous operation has been far from complete, and in this latter case, a bowel knuckle or a larger surface may be adherent to the scar. The abdominal wall may be so infiltrated that to feel, it seems a part of the conglomerate mass; but this mass should be rendered into these different component layers, some of which are to be left and some of which we aim to remove.

We now take a complicated case. If this method is worth while in the worst cases, it will work in the less complicated.

We have visualized the condition; we have laid our plan. We do not know where or when we will encounter pus pockets or open viscera. We must be ready and not be caught short, either materially or mentally. In order to clear the field and not let pent up infection be distributed, a working suction apparatus should be at hand.

The first layer—the abdominal wall—must be opened and separated from adherent structures. Theoretically, this should be the omentum, but in case of operative scars it may be loops of bowels. The omentum may be irregular. To avoid an adherent bowel or a displaced bladder, the peritoneum should first be opened at the upper end of the incision where nothing is adherent. The incision should be carried low to facilitate the pelvic approach. In old scars, progress downward should be made

with great caution; what seems to be an adhesion may be a stretched out knuckle of bowel and may inadvertently be opened. The abdominal wall layer should be separated from the layer below, from above downward. In these badly complicated cases carrying dormant or pocketed infection, there is much to be said against generalized exploration of the abdomen with the hand; but if for any reason it seems desirable to palpate the upper abdomen, this is the safest time to do so, not delaying it until all infected tissues and bacteria carrying pockets have been exposed.

The omentum in case of no previous operation may be evenly and symmetrically distributed and should be approached from below, and carefully detached from below upward, and displaced upward, and held out of the way with moist gauze pads. In case of a previous operation the omentum will be more unevenly distributed and perhaps there will be more low adhesions. The separation from the abdominal scar may leave a hole in the anterior omental layer. Separated fingers of omentum may run here and there to attachments where they have been most needed and may have to be tied off before they can be displaced upward out of the way. This fingering to certain needed areas may not be entirely absent in the absence of previous operation, but it is accomplished with more intactness.

With the abdominal wall and omentum out of the way the mass has become less in size, yet nothing has been removed. The next layer may be so complete that the uterus or tubes are not yet seen, or this layer, composed of sigmoid, cecum, small bowels and perhaps the bladder, may be incomplete, leaving the uterus and perhaps the tubes exposed. Practically all of this layer is to be preserved, and with its changed pathological state should be approached with great care, lest bowels be injured or separated from their mesenteric attachments. Lines of cleavage should be sought and carefully followed. Any attachment of small bowel should be carefully

separated from below upward—their mesenteries would be on the upper side, and any effort from above downward might easily detach the bowel from its blood supply. Next the sigmoid should be separated carefully from below and forward, in a backward and upward direction. The cecum and appendix should, if disposed over the uterus and tubes, receive like treatment. The bladder, if adherent, should be worked off from backward toward the front. This may have to be started by incising a binding adhesion. This has again greatly reduced the size of the tumor by freeing the mass of structure which is to be saved. In working at these masses which have attached themselves to the tubes, ovaries and uterus, it is quite possible to consider them a part of the mass to be removed and with the hand above the mass, tear the sigmoid from its mesentery. The line of cleavage must be sought as stated and the bowel worked off from before backward.

We have come now to the real mass which in severe cases is likely to need removing. As compared with the original mass, it may be very moderate in size. In some cases of even large pus tubes, the uterus and an ovary or a part of an ovary may be left. The uterus may contain a fibroid. With or without this, the uterus and tubes may be impacted and not easy to remove from the pelvic cavity. Pressed hard against the bony pelvis wall are the ureters, vessels, nerves, rectum and bladder, all of which should be left uninjured and disturbed as little as possible. A moderate, careful effort may be made to insinuate the hand between the pelvic wall and the mass. This will be facilitated by traction upon the uterus with a strong forceps. If this is not successful, consideration of the fifth layer, which is to be left intact, calls for a bisection of the uterine mass, or the removal of a wedge-shaped piece, or a core of the uterus. With the uterus and tubes out of the pelvis, stripped of all attachments, a really complicated case may present as clean cut a case for a

four point clamp and tie hysterectomy as an uncomplicated case. If there have been unavoidable holes left in the bladder, ureter, rectum, sigmoid or ileum, any of which have at times occurred, we proceed to their repair if available tissue is present.

Drainage through the vagina was done when drainage was thought necessary, but in later years a stab wound outside the rectus has been used with greater satisfaction. Drainage is considered in these conditions: (1) evidence of weakness in bowel wall with poor repair tissue, putting drain near, but not at the weak place; (2) deep oozing not readily controlled; and (3) considerable evidence of active infection.

We believe that less harm is done by a cigarette drain removed early if not found necessary, than by an infection becoming active without drainage.

We believe that the plan of reducing these large complicated masses to their component parts, rather than haphazardly seeking a place to put the next suture, has been an important factor in the reduction of mortality and morbidity.

No one feature of the after-treatment had a more salutary effect than the installation of a separate recovery room where the later methods could be carried out. The mortality and morbidity records could easily have been lowered if the first half of these cases had had the advantages of the latter half; and if none of them had lacked the benefits of blood, blood plasma and glucose intravenously, a better showing might have been made; but these cases were without the means to draw extensively on these helps. However, when we review the 493 patients, many of them in desperate condition upon entrance, a mortality as low as 1.42 per cent seems not unreasonably high. A glance at the causes of death in the seven cases would seem to indicate that some of these might have been saved; but when we remember that only seven patients died, it will be seen that patients in this series were not

allowed to die without active measures having been used to save them.

#### SUMMARY

In a series of 493 operative patients who had partially arrested pelvic infections with gross pathological conditions of the pelvic organs, the etiological factors were in addition to the ever possible gonococci, abortions and the puerperium with their concomitant injuries which served as a media for the pyogenic organisms. As to age incidence 78.7 per cent of the women were below thirty and nullipara predominated. From the bacteriological study of 100 cases streptococci were found to be the predominating organism. The pathological states showed a wide variation of involvement. The clinical course was fairly characteristic while the atypical cases required differentiation from simulating conditions such as ectopic pregnancy, fibroids, endometrioma and carcinoma of the uterus. Surgical treatment is considered only when permanent end changes occur in the pelvic structures resulting from infections. In the choice of operation, there was a distinct leaning toward conservatism. The important steps in surgical treatment are proper preparation of the patient, proper election of time of operation and rational conservation of tissue. The mortality rate is 1.42 per cent in this group analyzed.

#### CONCLUSIONS

From the analysis of a large number (493) of patients operated because of pelvic disorders unresponsive to medical measures, and from the bacteriological and pathological examination of the Fallopian tubes removed, it is concluded that:

1. Though the gonococci may be common primary and secondary invaders, pyogenic organisms play the chief rôle

in permanently destroying the female pelvic organs.

2. In these conditions methods of treatment other than surgical are at best palliative only.

3. As the pyogenic organisms are so commonly found in the tissues, especially the streptococci, due time must elapse between the last acute exacerbation and the operation to allow immunization of the patient. Though the dormant bacteria were found to be virulent yet were avirulent in the presence of the active antibodies of the patient.

4. The best guides at present for determining the proper time to operate are temperature, leucocyte curve and the degree of tenderness in the lower part of the abdomen.

5. The above principles have a firm basis as they were followed in the treatment of the described series of patients with the resulting mortality of 1.42 per cent which is the lowest in the reported literature.

6. The method of dealing with conglomerated masses as detailed in the *plan of operation* we feel sure had much to do with a low mortality.

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# TOPICAL APPLICATION OF HORSE SERUM IN THE TREATMENT OF EXTENSIVE BURNS

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WHILE the increased incidence of burns in civil life has attracted considerable attention mainly because of the fire hazards resulting from overcrowding and the apparent nature of the materiel used in the manufacture of ammunition and allied inflammable products, the ever increasing potential hazards encountered in combat by sea, air and highly mechanized land warfare have given added impetus to a critical study of the management of burns in our armed forces and in all theatres of warfare throughout the globe. It is not the intention of this paper to review the multiplicity and diversified views expressed on the subject of the management of burns but rather to take into consideration all of the newer concepts of the disturbed physiology resultant from burns and to crystallize a simple, adequate, applicable form of treatment which could be utilized under conditions of the various exigencies of combat as well as civil emergencies. Obviously, treatment which is based upon silencing the source of the trigger mechanism mediating the remote disturbed physiology in burns and combating the latter with appropriate measures is most desirable.

In 1923, one of us (H. M. R.) in charge of several extensive burns, made the observation that the excessive blood plasma the body pours out over a burned skin area several days after the original burn, does not jell or coagulate readily under the heat of an electric bulb, which was then being used in the local treatment of burns. Moreover, the local application of horse serum to the burned area yielded an adequate jelling of the plasma under

the heat of the same electric bulb. Since serum does not contain fibrinogen, it was pointed out that a substance other than fibrinogen was responsible for the adequate jelling or coagulation of the plasma in the burned area. Based on this phenomenon, it was believed at the time that the local application of horse serum tended to act as a physiological plug to excessive plasma loss in addition to the healing and bactericidal properties of serum and plasma.

Based on this concept for upwards of fifteen years the topical application of normal horse serum was used in severe burns. A review of the literature revealed a case report by Robinson<sup>1</sup> in 1917 and later reported by Montieth and Clock.<sup>2</sup> In our series, freedom from pain, toxemia, and the low incidence of severe dehydration was an outstanding feature in all the cases regardless of the degree of burn. This of course excludes those patients who made an exitus in the first few hours after admission. By far the most gratifying observation was the perfect epithelization (Figs. 1 and 2) of the burned area, which obviated the necessity for skin grafting. It is because of these facts that it was believed the collected fifty-two cases deserved reporting particularly at this time in the face of the expectant burn hazards of highly mechanized warfare.

The method of treatment of severe burns consists of the following steps:

1. Treatment of burn shock: It is this stage that has received the most attention in the literature during the past few years. Although transfusions were used generously in the early years of this method of treatment, it is conceivable that the results would have been further improved

if plasma<sup>3</sup> transfusions and adrenal cortex extract<sup>4</sup> were available.

2. Breaking of the blebs, if readily accessible, with sterile scissors.

to us to be remarkably fast. The absence of infection and pain was most outstanding. The healed burns exhibited little or no scarring and contractures commonly due



FIG. 1. A, anterior view; B, posterior view. J. P., age seventy, male, third degree flame burn of right forearm, hand and fingers, extent of lesion self-explanatory. Treated with human plasma by spray for six days and thereafter with horse serum.

3. No washing of the burn unless grossly contaminated and no débridement.

4. Spraying of the burn with normal horse serum, with a non-metallic atomizer, at first every hour, then at longer intervals. A small heat lamp is played over the area until the serum and plasma are coagulated.

5. After about ten days to two weeks, the burned part is soaked in sterile saline, and as the eschar separates, spraying and saline washings are repeated until complete epithelization takes place.

Fifty-two patients with severe burns of second and third degree were treated in this manner. Eight patients in whom more than 75 per cent of the body surface was involved did not recover and died within a few hours. This is a common finding with all accepted treatments. In the recovered cases, the rate and extent of healing seemed

to burns were not in evidence. In only one case was there evidence of a reaction due to the medication, and that was a case of mild serum sickness (hives) in a severe burn. This reaction required no treatment. In spite of the splendid results of the therapy, individual treatment of a patient is still important. The active and passive motion are necessary especially in the neighborhood of joints. Figures 1 to 12 are self-explanatory and are typical of all the cases. The shaded areas represent second and third degree burns of the skin, and the treatment given is abstracted in the legend beneath each figure.

#### EXPERIMENT

Since it is virtually impossible to compare accurately the healing time of burns in actual patients, because of difference of

the extent of the burn, differences in the time before institution of treatment, and differences in the resistance of the indi-

Group II: Five rats were sprayed with tannic acid.

Group III: Five rats were swabbed with

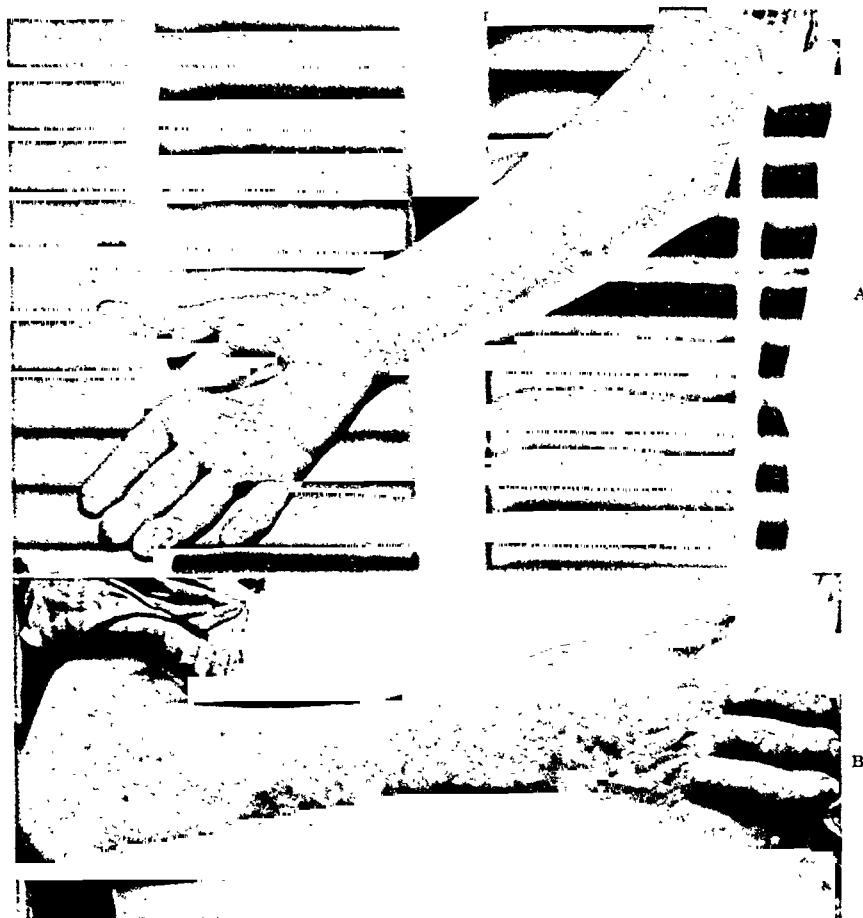


FIG. 2. Same case as in Figure 1. A, anterior view; B, posterior view. Complete epithelization without gross scarring in forty-eight days. Active and passive motion was started in ten days.

vidual, one of us (L. P.) sought for a laboratory method whereby we could control these variables.

Fifteen adult rats of approximately 175 Gm. in weight were used. An area of  $2\frac{1}{2}$  cm. square on the lateral body wall was clipped free of hair and burned with an electrically heated cautery iron under anesthesia. The iron was moved around continuously so as to get a fairly even burned area. In each case, the burn approximated a third degree burn. According to plan the following medicaments were immediately applied.

Group I: Five rats were sprayed with normal horse serum containing 0.30 per cent cresol.

silver nitrate and then sprayed with tannic acid.

The rats were treated in this way three times on the day of injury and once each day on two ensuing days. The animals were observed each day. None of the rats died of the burns, and none gave any indication of pain following application of the medicaments. At the end of one week, the healing was appraised, the animals were sacrificed by anesthetization with ether, and full thicknesses of the burned skin were taken for gross and microscopic examination.

The differences in the groups of rats were marked. In the serum-treated rats at the end of one week, there were no

evidences of infection; there were attempts at healing; in several cases there were evidences of partial epithelization of the

a physiologic basis. Recently, there appeared two divergent schools of thought on this subject. One group recommended

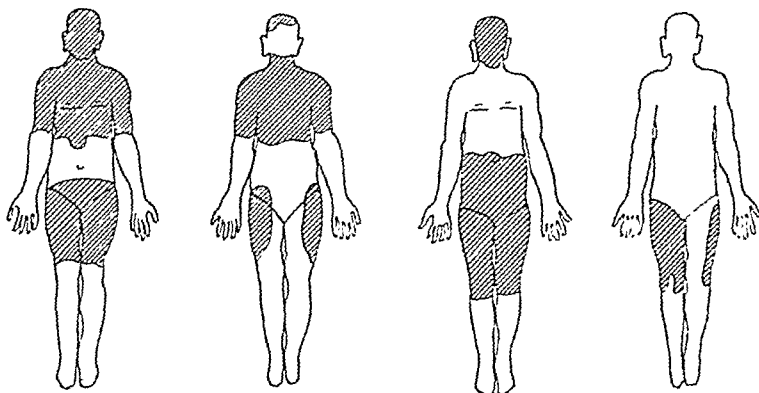


FIG. 3.

FIG. 3. Case XI. J. L., age twenty-four, male. Steam burn in Turkish bath. Ran septic course from the fourth to the thirteenth day and then improved. Had 500 cc. of blood on ninth day. Burn healed without scarring in thirty-two days.

FIG. 4.

FIG. 4. Case XIV. L. F., age four, male. Hot water burn. Received 200 cc. of blood. Horse serum applied for seven days, then saline dressings. Healed in nineteen days without scars or contractures.

burned surfaces. The crusts on these surfaces were soft and pliable. In the tannic acid-treated rats, the burned areas were covered with a heavy, unyielding tan under which there were invariable evidences of suppuration. In the group of silver nitrate and tannic acid-treated rats, the coagula were thicker and heavier than that of the previous group. Otherwise the findings were essentially the same.

The burned areas were then examined for pliability. The serum-treated wounds were extremely yielding and soft, while the tannic acid-treated wounds, and the heavily tanned wound of the tannic and silver nitrate group were stiff and not pliable. The microscopic sections made from these wounds showed comparable changes. However, these sections showed that it was impossible to burn the animals so that the exact microscopic layers were involved similarly in each case.

*Comment.* For many years, the tanning<sup>5</sup> treatment of severe burns has held the spotlight. While this treatment was without doubt an improvement over the methods that were used previously, it has always appeared lacking when viewed from

other coagulating substances to be used along with the tannic acid, so as to get a thicker, heavier and, therefore, more unyielding tan.<sup>6</sup> Another, led by the eminent C. P. G. Wakeley,<sup>7</sup> has caused us to believe that the tannic acid treatment of burns is associated with an amazingly high mortality. Certainly it is true that war burns, due to the fact that they are predominantly face and hand burns, are not particularly suited to the prolonged splinting of an unyielding tan because of the danger of contractures. A heavy leather covering would, *a priori*, seem to be an unphysiological environment for the growth of the delicate new skin cells and would, therefore, necessitate much skin grafting. That this is a fact is common knowledge. Recently, several workers<sup>8</sup> experimentally produced necrosis of liver cells in the central portion of the lobule, by injecting small quantities of tannic acid into rats. This central lobular liver necrosis is a prominent finding in deaths caused by burns and treated with tannic acid and the implications are in a measure suggestive.

One of the most gratifying effects of the treatment is the freedom from pain. The

excruciating pain of a burn ceases almost immediately following the application of horse serum. The amount of morphine that

cresol that keeps the horse serum sterile, could be a factor in keeping the wound sterile. It must certainly be true that

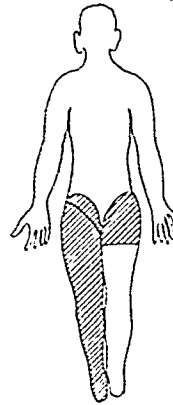
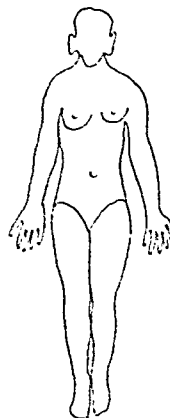
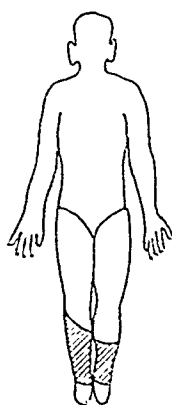
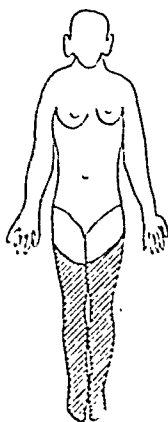


FIG. 5.

FIG. 6.

FIG. 5. Case xxvii. F. D., age seven, female. Hot water burn. Received tannic acid treatment at home. Temperature elevated on fifth day and continued to fifteenth day. Healed without scarring in thirty-five days.

FIG. 6. Case viii. I. G., age fifty-four, female. Hot water burn. Infected burn following two weeks treatment with tannic acid at another hospital, tan lifted. Horse serum applied, healing wound in fourteen days.

has to be given is very small indeed, even in severe burns. It can be postulated that the reason for this is that the serum coating protects the injured tissue from the air, and its pliability does not penalize the patient for the almost constant and often unavoidable movements that he goes through. Although the premise sounds quite reasonable, it must be admitted that exposing the raw surface to air is not the cause of pain in burns, because another type of wound of comparable size, so exposed is not usually painful. In 1937, Rosenthal<sup>9</sup> found in the blood of burned animals a histaminoid substance. This substance would doubtless be an irritant to the sensory nerve endings, and produce severe pain.<sup>10</sup> Rosenthal<sup>9</sup> found that this histaminoid substance was neutralized by serum from humans and animals in the healing stage of burns, and that even normal serum would do this to some extent. In the topical application of normal horse serum to burns, this toxin is neutralized at the source.

The absence of infection in the serum-treated wound is striking. It is doubtful, however, that the small concentration of

something in the horse serum helps the superficial layers of cells to fight the bacteria that seek to destroy them. The bactericidal activity of normal horse serum has been the subject of many extensive reports chiefly by Gordon,<sup>11</sup> Mackie and their co-workers. Their conclusions were that there was present in normal horse serum the precursors of immune antibodies, although specific natural antibodies for certain bacteria were not present. Gordon thought that the bactericidal activity of normal horse serum was due to its content of complement and a heat stable intermediary factor. This factor was absorbed by the bacteria and was toxic to them.

Earlier in the paper, reference is made to the pouring out of an excessive amount of plasma from the burned area with failure of the plasma to jell adequately. The burned area literally appears to weep torrents of plasma. It does not make sense to continue to pour plasma into the circulation while it seeps out of the burned areas like rain through a porous roof. The accumulation of plasma in the tissues around the burned area may still be restored to the vascular system if and when



the constant seepage of plasma oozing out of the burned surface is physiologically plugged. For many years the principles

e.g., ( $-SH$  group) which is an intermediary of cystine, e.g., ( $-SS$ -group) metabolism definitely prevents the for-

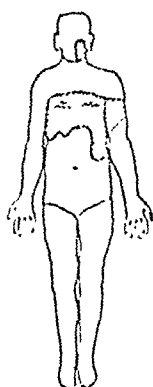


FIG. 7.

FIG. 7. Case xxiii. I. L., age six, male. Hot water burn. Healed in sixteen days without scars or contractures.

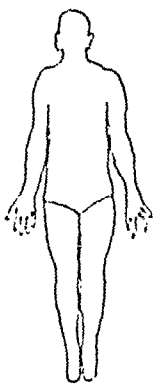


FIG. 8.

FIG. 8. Case xxxii. J. F., age thirty-four, male. Fire burn due to clothes catching fire. Tannic acid treatment at another hospital. Eschar covering burn undermined with pus. Eschar removed and horse serum sprayed after saline soak for one day. Epithelization complete in fifteen days.



FIG. 9.

FIG. 9. Case xx. S. R., age twenty-one, female. Ignited alcohol burn. Temperature on admission  $104^{\circ}F.$ , then fluctuated for five days. In ten days, elbow exercises instituted. Healed in nineteen days except for slight granulating wound.

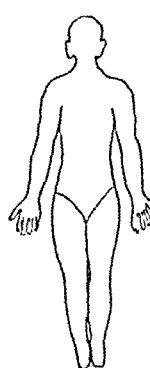
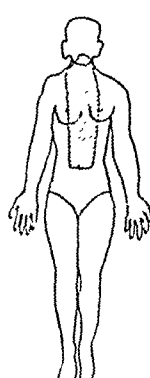
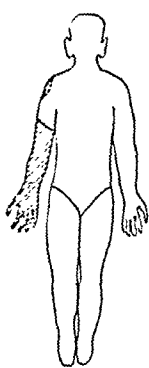
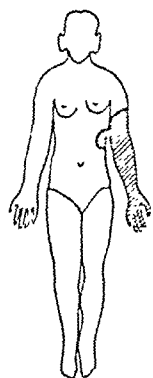


FIG. 10.

FIG. 10. Case iii. K. B., age two, female. Hot water burn healed in twelve days.

involved in the alteration of proper jelling of the plasma in burned areas and the mechanism by which application of normal horse serum to burned areas tended to re-establish adequate jelling was not under-

mation of a firm retractile coagulum. It is conceivable that in the face of excessive protein breakdown such as is very much in evidence in burns, that cystine, e.g., ( $-SH$  group) vitiates the adequate jelling



stood. Recently, Rabinowitz<sup>12</sup> has pointed out the important rôle that the sulfur amino acids, such as cystine and methionine, play in the mechanism of normal clotting and clot retraction. Cysteine,

of the plasma in the burned area. In advanced stages of prolonged toxemia in burns with liver damage, it is likewise conceivable that adequate cystine metabolism is impaired with resultant general

preponderance of the (SH-group) e.g., cysteine. In that event, the picture would be parallel to that of thrombocytopenic

cells. The heavily tanned areas can be compared to the cellophane in the example cited above. The thick, unyielding coating

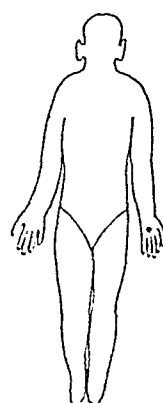
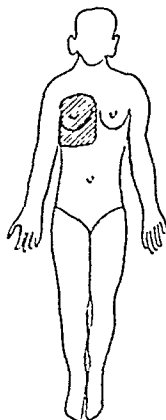
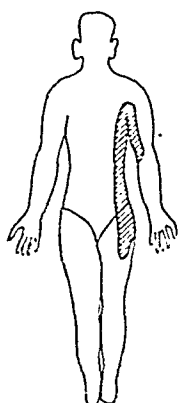
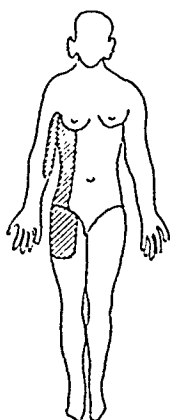


FIG. 11.

FIG. 12.

FIG. 11. Case XXVI. M. B., age seven, female. Flame burn, due to matches. Temperature ran from 101° to 103°F. for nine days, then flat. Rose to 103°F. on twenty-fifth day and continued high until thirty-second day. Had two transfusions of whole blood. Healed in sixty days without scarring or limitation of motion.

FIG. 12. Case XXX. R. R., age forty-two, female. Boiling water burn three days before admission. At that time necrotic areas completely encircled breast. Septic temperature for fourteen days. Two transfusions given. Purulent area had to be incised. Developed serum sickness (hives) on eighteenth day. No treatment required. Epithelization well along on thirty-sixth day.

purpura.<sup>12</sup> Purpuric manifestations and gastroenteric bleeding in the late stages of severe burns is not uncommon and lends added importance to the postulate. Serum or plasma causes a rapid disappearance of the (—SH) groups, e.g., cysteine. Furthermore, normal serum contains cystine and methionine<sup>12</sup> which tend to restore firm clotting and clot retraction and thereby act as a physiological plug to the constant seepage of plasma from the burned area.

Du Nouy,<sup>13</sup> in his intensely interesting book, "Biological Time," gives some hint why unyielding and heavily tanned areas are unphysiological, retard healing and often require skin grafting. When part of a wound is covered by a sheet of sterile filter paper, it can easily be seen that the epithelization progresses more rapidly when the cells have been protected. On the other hand, when the wound is covered by a sheet of impervious cellophane, there is complete inhibition of the growth of

does not act as a bridge for the growth of the delicate young tissue cells, as does the serum coagula.

The local application of horse serum acts as a "sparer" of the natural mobilization of plasma over the burned area. The outpouring of plasma appears to be an attempt on the part of the organism to replenish the protein destruction caused by the burn. If horse serum is applied to a burn surface, and is artificially coagulated by heat, we may be "sparing" the body's content of plasma by physiologically plugging the leakage over the burned area. Since epithelization takes place along a fibrin network, it does not take place readily in large burns unless aided. The artificially coagulated applied serum and wound plasma act similarly to a fibrin network and aid epithelization.

Since plasma contains fibrinogen it appeared to be ideally suited for this purpose and it was decided to use human plasma topically on one case. A third

degree burn involving almost the entire right forearm (Fig. 1), hand and fingers was treated with plasma in conformity with the previously stated horse serum routine. However, it was impossible to continue this treatment beyond the sixth day because of the expense incurred. The remainder of the treatment was carried out with normal horse serum. It was noted that the burn healed completely without gross scarring (Fig. 2) or contractures. If the cost of human plasma can be brought down, it would probably be ideal for topical application in burns. In the meantime, artificially jelled normal horse serum remains a tried and efficient substitute.

If we list for didactic purposes, the stages of reaction in burns,<sup>11</sup> as primary shock, secondary shock, acute toxemia, and septic toxemia, we can see how horse serum applied topically acts as more than a local coating for the burn. Primary shock arises immediately after a burn, and is probably due to pain and fright. If the horse serum is immediately available, pain is at a minimum and this period would be extremely short. Otherwise adequate doses of morphine must be given. Secondary shock is ostensibly due to increased capillary permeability in the burned area, and indeed over the entire body. If the outpouring of plasma over a burned surface is due to nature's attempt to replace the destroyed protein, the leakage can be limited at its source by applying jelled horse serum or human plasma. If hemoconcentration and hypotension develop, intravenous administration of plasma is the appropriate medication. The acute toxemia or toxic stage of a burn usually occurs forty-eight to seventy-two hours afterward. There is much evidence to show the existence of a toxin in the burned area. The edema fluid of a burn gradually becomes more toxic. The blood of burned animals contains a histaminoid substance which can be antagonized in part by normal serum. By the application of serum this substance is antagonized at the outset. The last stage

of septic toxemia is due to bacterial infection of the burned area. Normal horse serum has been shown to be definitely antagonistic to the growth of bacteria.

In the entire series, only one case showed a mild form of serum sickness. It was thought unnecessary for this reason to skin test the patients before the use of topically applied serum. This case of serum sickness was of the type that occurs regularly in non-serum sensitive patients following the injection of horse serum.

Although in this study, topical application of appropriate medicaments was studied from the standpoint of healing, this should not be taken to minimize the importance of the recent work on the general treatment of burns, such as plasma transfusions and the adrenal cortex treatment of burn shock. However, it is our impression that investigators have placed too little stress on local treatment. The ideal consists of a balanced combination of both of these methods.

The advantages of local serum application over other forms of treatment are: (1) The processing and economic yield of horse serum has long been established and is easily transportable. (2) The application of serum obviates cumbersome dressings and permits of rapid evacuation of location. (3) The administration of sedatives or narcotics is reduced to a minimum resultant from freedom from pain. (4) Hypoproteinemia and dehydration are prevented in a great measure with resultant reduction of the use of intravenous plasma. (5) Painful and time consuming débridement is rendered unnecessary. (6) Adequate epithelization and absence of debilitating scar tissue eliminate skin grafting in a great measure.

#### SUMMARY

1. Fifty-two patients with severe second and third degree burns were treated by the topical application of normal horse serum. These cases were studied over a fifteen-year period.

2. The lack of infection, the absence of pain, the speed of epithelization, and the comparative absence of scarring were striking features.

3. A short note on the topical application of human plasma in severe burns is inserted.

4. No skin grafting had to be done on any of these patients.

5. The rôle of the protein degradation products, cystine, cysteine and methionine, in the process of plasma coagulation in burned areas was discussed.

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# EXOPHTHALMOS\*

## DIAGNOSIS AND SURGICAL TREATMENT OF INTRACTABLE CASES

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THE causes of exophthalmos, which attracts special attention in large thyroid centers, are many. For that reason, one must be acquainted with the differential diagnosis so that an orderly investigation as to etiology can be conducted, and as soon as the diagnosis has been made advice as to treatment and probable prognosis given. (Table 1.)

In the normal person the prominence of the eyeballs varies considerably. The normal range, as measured by the exophthalmometer, is from 10 to 20 mm. Many persons are normally so-called "pop-eyed," and prominence of the eyeballs may be a family characteristic. The word exophthalmos should be used only to describe abnormal protrusion of the eye or eyes, which should not be confused with the stare so frequently associated with hyperfunction of the thyroid gland. Whether a protrusion has occurred or is in progress is usually evident or volunteered by the patient, his family or friends.

Thyrotoxicosis, which is the most common cause of exophthalmos, is usually bilateral but may be unilateral. In the majority of cases the diagnosis is not difficult because of toxic signs, although in three of our patients rapidly progressive exophthalmos was present one to three months before the toxic manifestations were evident.

In a large series of patients with hyperthyroidism, Cattell<sup>5</sup> found that 21 per cent showed persistence of the preoperative exophthalmos, but only 1.1 per cent showed an increase following operation. The latter patients are of especial interest to the neurosurgeon since in a few cases the exophthalmos will progress to such a

TABLE 1

EXOPHTHALMOS: BILATERAL AND UNILATERAL Etiologic Factors, Eighty-seven Cases, 1933-1943	
<i>Systemic</i>	
Thyroid disease.....	28
Hypertension.....	5
Syphilis.....	1*
Leukemia.....	1
Angioneurotic edema.....	0
Prolonged use of thyroid extract in obesity....	2
Pyemia resulting in orbital abscess.....	1†
Paget's disease.....	2
<i>Intracranial pressure (causing pressure erosion of orbital plates)</i>	
Brain tumor.....	4
So-called "increased intracranial pressure without tumor".....	2
<i>Congenital</i>	
Encephalocele.....	0
Aneurysm {arteriovenous (orbital varicosity).. internal carotid and ophthalmic artery.....	1 1
Cranial synostosis.....	2
<i>Orbital tumors</i>	
Sphenoid wing meningioma (hyperostosing)....	11
Schüller-Christian disease.....	0
Osteoma.....	3
Cholesteatoma.....	3
Carcinoma {metastatic..... primary nasal sinus.....	2 1
Sarcoma {osteogenic..... neurogenic..... rhabdomyosarcoma.....	1 1 0
Angioma {arterial..... venous..... lymphangioma.....	1 1 0
Glioma of optic nerve.....	2
Neurofibroma.....	1
Mucocele.....	1
Pseudotumor.....	1
Mixed tumor of lacrimal gland.....	1
Lipoma.....	0
Fibroma.....	0
<i>Infections</i>	
Osteomyelitis {pyogenic..... tuberculous..... syphilitic.....	1† 1 1*
Cavernous sinus thrombosis.....	2
Orbital abscess.....	1
Infection of lacrimal gland.....	1
<i>Trauma</i>	
Hematoma of orbital tissues.....	1
* Same case.	
† Same case.	

\* From the Department of Neurosurgery, The Lahey Clinic. Presented before the meeting of the Inter-State Post Graduate Medical Association of North America, Chicago, October 28, 1942.

degree that orbital decompression is necessary to save the vision.

Our experience with surgical treatment

extensive orbital decompression is progressive exophthalmos in the presence of increasing visual changes, which sub-



FIG. 1. *a*, a moderate degree of exophthalmos, with marked conjunctival edema, extra-ocular muscle palsy and papilledema of the optic disks. The chemosis of the left eye is so great that keratinization has taken place; in this type of patient lateral tarsorrhaphy may be of value after the decompression. Great swelling of the upper eyelid can also be noted. *b*, two months following operation, with a lid suture of the lateral canthus. The edema of the left upper eyelid and chemosis have subsided to a great degree. *c* and *d*, definite progressive exophthalmos with only slight chemosis and swelling of the eyelids. Exposure hyalinization and overvascularization of the conjunctiva medially which corresponds to the width the eyelids are open even while asleep. Patient had corneal abrasions but no papilledema. *e* and *f*, after orbital decompression.

for severe progressive exophthalmos has been limited to twenty-eight patients since 1933. In most of these cases sufficient time has elapsed so that the clinical course and end results can be ascertained fairly completely. Eleven of the patients were males and seventeen females. Their ages ranged from twenty-seven to sixty-seven years.

The indications for operation are not always clear, resulting in a conflict of opinions as to whether a patient should be subjected to orbital decompression. The operation is neither suggested nor advised for purely cosmetic purposes, although a striking improvement in appearance usually results. The only real indication for

jectively usually consist of diminished, blurred or double vision with photophobia and lacrymation. Obviously, acute swelling of the lids, chemosis and sometimes keratinization of the conjunctiva may be present. Epiphora is distressing and leads to frequent eye wiping and subsequent bouts of acute conjunctivitis. External ocular muscle palsy is common. An occasional patient shows corneal ulceration and extension of infection. The width the eyelids are apart often can be determined accurately when the patient is asleep, or the inability of the eyelids to close can be determined by the degree of discoloration of the conjunctiva at the lateral and medial portions of the eyeball.

(Fig. 1c.) The fundus may appear normal or show venous congestion and varying degrees of papilledema. If the process is

The evaluation of previous statistics in the measurement of exophthalmos is difficult, particularly if one depends upon



FIG. 2. Progressive essential hypertension with sudden development of arteriovenous aneurysm producing pulsating exophthalmos of the left eye with marked conjunctival edema. *a*, previous to operation; *b*, five months after ligation of the common carotid artery and bilateral splanchnicectomy.

unrelieved, subluxation of the globe, blindness or even meningitis and death may result. Infrequently, long-standing, marked exophthalmos may be associated with slight optic atrophy and an occasional extra-ocular muscle palsy, and yet such a case may not fall into the category of progressive exophthalmos. Operative indications can be determined only by a long period of observation.

The prevention of these symptoms and signs should concern all who come in contact with suspicious cases. Any patient with exophthalmos which fails to recede or increases following thyroidectomy should be under the observation of a physician competent to determine whether surgery is indicated. The optimum time is variable and depends somewhat upon the surgeon's experience and previous observations, but in a patient without thyrotoxic symptoms and with severe, progressive exophthalmos (usually a protrusion of 25 to 30 mm.), progressive visual changes, and a normal or subnormal basal metabolic rate, orbital decompression unquestionably is indicated.

the so-called grading system. Due to puffiness of the eyelids and variable degrees of conjunctival edema, false impressions are obtained easily, and the actual proptosis may be greater in the seemingly less prominent eyeball.

The exophthalmometer in experienced hands has done much to improve our records at the Lahey Clinic. Measurements are taken routinely in the re-examination of thyroid patients showing exophthalmos, and at the earliest sign of progression, with the visual changes already described, the patient is seen in consultation by a neurosurgeon. A description of the actual use of the exophthalmometer is unnecessary, since one should be well acquainted with it. Because of the discrepancy in readings made by different persons on the same patient, whenever possible the pre-operative, postoperative and follow-up readings should be made by the same person. Our measurements have been made with the Hertel exophthalmometer which registers a normal figure of 15 to 17 mm. In order to estimate accurately

the amount of improvement or progression in a given case, the use of the same base line throughout is important.

years, the actual visual symptoms for which operation was indicated preceded decompression by only one and a half to

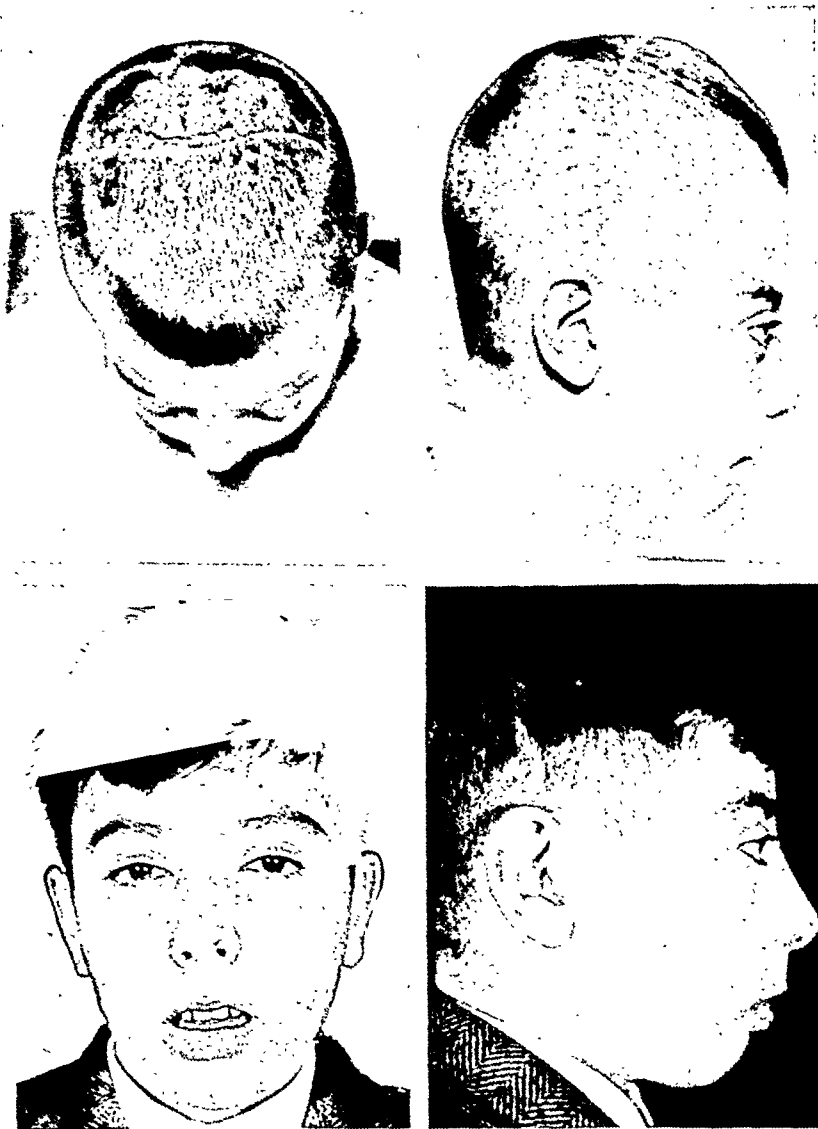


FIG. 3. Bilateral exophthalmos from cranial synostosis. The prominence of the eyeballs is still noted eight days following artificial production of suture lines as described by King.<sup>12</sup> Eyes and head are normal two years following operation as demonstrated by the lower photographs.

The preoperative maximum and minimum readings in our patients varied from 37 to 19 mm. respectively, twenty of the twenty-eight cases having protrusion of 25 mm. or over. In eight the measurements were exactly the same in the two eyes. The others showed 1 to 6 mm. of difference in the two eyeballs.

In twenty cases progressive exophthalmos appeared following the first thyroidectomy. Even though exophthalmos of some degree usually was present before thyroidectomy for periods of one month to six

ten months. Marked visual changes were almost always recent in duration (one to three months). This illustrates that the development of exophthalmos is not always in direct proportion to ocular signs and symptoms. (Fig. 1a.)

Four of our patients showed no alteration in the orbital tissues until after a second thyroid operation. In two cases exophthalmos reached the progressive stage concomitantly with a thyrotoxicosis sufficient to necessitate a thyroidectomy followed within three months by an orbital



decompression. One patient showed advanced visual changes necessitating orbital surgery approximately four months prior

Correlating the degree of exophthalmos with ocular paralysis, the latter was more frequent, with moderate rather than severe

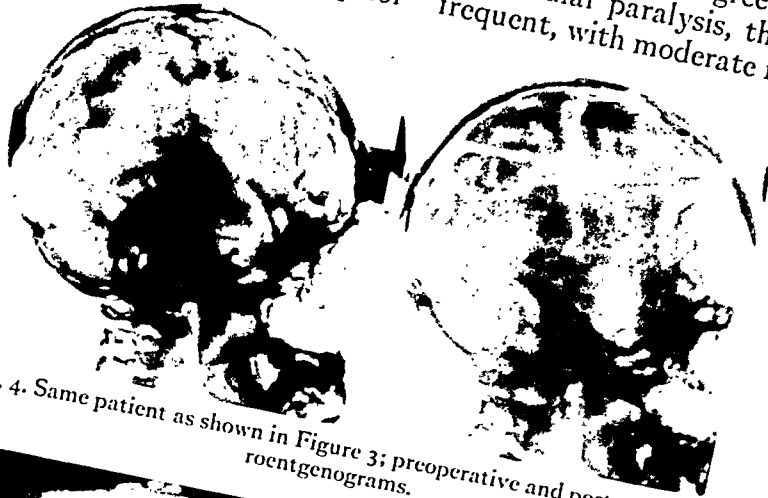


FIG. 4. Same patient as shown in Figure 3; preoperative and postoperative roentgenograms.

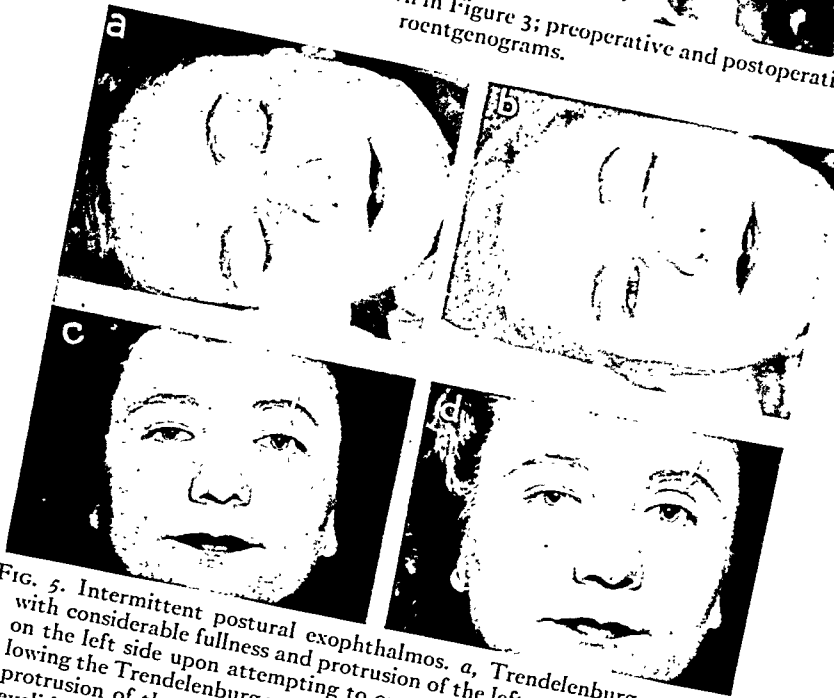


FIG. 5. Intermittent postural exophthalmos. *a*, Trendelenburg position, with considerable fullness and protrusion of the left eyeball. *b*, lid droop on the left side upon attempting to open both eyes; *c*, one minute following the Trendelenburg position, in the upright position; considerable protrusion of the eye, the arrow pointing to the fullness of the upper eyelid; *d*, upright position two minutes after *c*; 8 mm. recession of the eye. The normal wrinkles can be seen in the upper eyelid.

to the indications for a subtotal thyroidectomy. One patient had roentgen therapy for toxic goiter ten years before orbital decompression. In the remaining two patients exophthalmos could not be related definitely to thyroid disease.

Apparently no direct relationship existed between the rapidity of the development of exophthalmos and extra-ocular palsy.

proptosis. The degree of resistance of the orbital tissues, which is almost like that of a brawny edema, can be determined by exerting pressure on the eyeball. If the tissue allows the eyeball to sink into it relatively normally, catastrophe is not imminent. Twenty-five patients presented limitation of the extra-ocular movements, usually in the horizontal and vertical

planes, indicating extensive muscle involvement. Nineteen patients mentioned diminished or blurred vision as a chief

six were associated with previous thyrotoxicosis. Twenty-four had primary thyroidectomies. One patient had had roentgen



FIG. 6. Tuberculous osteomyelitis arising in the left maxillary sinus with definite exophthalmos and complete ophthalmoplegia caused by swelling of the retro-orbital tissues.

complaint, and sixteen complained chiefly of double vision. In one patient blind spells caused the greatest difficulty.

Eleven patients specifically mentioned marked lacrymation, but objectively this was present in all cases. Three showed photophobia, and only one complained of headaches. Sixteen patients showed varying evidences of papilledema. This ranged in degree from the appearance of early changes to an elevation of 5 diopters, and among these cases two showed early optic atrophy. Six further patients showed venous congestion and two of these had moderate pallor of the disks. One patient had pallor alone. The remaining five patients showed essentially normal fundi. Two had corneal ulcers or scars preoperatively.

The basal metabolic rate was determined in twenty-five patients just preceding orbital decompression and varied from -20 to +21 per cent. Four had distinctly low levels, varying from -16 to -26 per cent, while only one had a rate above normal (+21 per cent). This patient was taking thyroid extract daily.

In our series of twenty-eight operative cases of progressive exophthalmos, twenty-

therapy ten years previously. One patient entered the hospital with a history not unlike that recently described by Brain<sup>4</sup> as exophthalmic ophthalmoplegia. The symptoms were unilateral, and no indication of thyroid involvement occurred until four months after orbital decompression. Subsequently thyroidectomy completely relieved the toxic symptoms. The other two patients had similar stories, with the exception that to date they have developed no manifestation of thyroid toxicity.

Before resorting to orbital decompression, in certain cases other measures were attempted in an effort to relieve the progressive state of the exophthalmos.

Thyroid medication was given a trial in nine patients with a low basal metabolic rate, but this failed to improve the ocular status. Three patients were subjected to three thyroidectomies and three others to two, but the exophthalmos was unrelieved and all had subsequent orbital decompression. Therefore, even though operations for thyroid remnants may be necessary in the presence of toxicity, such procedures have no helpful effect on an existing progressive exophthalmos.

Lugol's solution was used in five cases. Only one patient thought there was slight, transient improvement in the exophthal-

discomfort from the dry nasal mucous membrane. Even though the lid droop may be of some help, there is no im-



FIG. 7. *a* and *b*, before operation, a downward forward displacement of the eyeball caused by osteogenic sarcoma involving the right frontal bone and orbital plate; *c* and *d*, same patient six weeks following operation.

mos, but this was not noted objectively. One patient who had a poor result after orbital decompression was subjected to roentgen therapy, but the exophthalmos became worse thereafter. Bilateral cervical sympathectomy has been disappointing in several cases, and one patient so treated had an orbital decompression two months later. Other similar cases in which the exophthalmos is marked but not typically progressive are being followed. All patients subjected to sympathectomy complain of

provement in the proptosis as measured by the exophthalmometer. Readings have been made by Cattell and Beetham<sup>6</sup> in several patients at the time of thyroidec-tomy while the cervical sympathetic chain was stimulated. A questionable 1 to 3 mm. change in protrusion was noted in patients with exophthalmos; no change was noted in patients without exophthalmos.

In 1931, Naffziger<sup>16</sup> introduced orbital decompression for the relief of certain patients who developed a severe form of

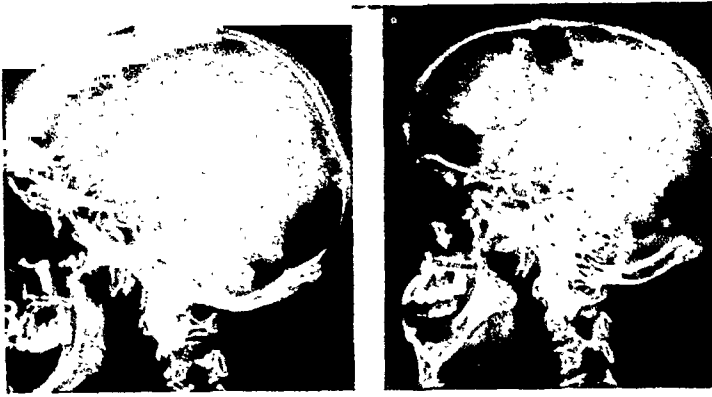


FIG. 8. Same patient as shown in Figure 7; preoperative and postoperative roentgenograms.



FIG. 9. *a* and *b*, unilateral exophthalmos from a retro-orbital neurofibrosarcoma; *c* and *d*, thirteen days following complete extirpation of retro-orbital tumor transcranially.

progressive exophthalmos following thyroidectomy. Previous attempts to relieve this condition had failed completely, and



FIG. 10. Exophthalmos caused by benign neurofibroma involving the first division of the trigeminal nerve retro-orbitally.

the patients went on inevitably through stages of chemosis, corneal ulceration and panophthalmitis, or developed papilledema, optic atrophy and blindness. Many were subjected to enucleation of their eyes as a lifesaving measure. Other procedures such as canthotomy, canthoplasty and tarsorrhaphy, plastic operations, removal of orbital fat, ligation of the superior ophthalmic vein, and division of the cervical sympathetic nerve, were of help in only a few of the less extensive cases.

Naffziger,<sup>19</sup> in his most recent article, reported the clinical aspects of thirty-one cases of orbital decompression, eight of which were from his own clinic. There were two deaths and four poor results. Other reports of cases include those of Semmes,<sup>24</sup> Merrill and Oakes,<sup>15</sup> Bothman,<sup>2</sup> Thomas and Woods,<sup>25</sup> Rosenbaum,<sup>22</sup> Brain,<sup>4</sup> Kistner,<sup>13</sup> Brady<sup>3</sup> and Guthrie.<sup>11</sup> These authors agree on the generally favorable results of orbital decompression, even though a few depict it as a procedure of great magnitude.

While the general method of performing orbital decompression remains essentially the same as described by Naffziger<sup>16, 17, 18</sup> in his original and subsequent articles, there are certain slight modifications, together with a few preoperative and postoperative suggestions which we have found helpful.

#### OPERATIVE TECHNIC

The patient is given a general anesthetic with avertin supplemented by endotracheal ether. Before placing the usual drapes for craniotomy, complete but temporary tarsorrhaphy is performed. This not only improves the operative result but reduces to a minimum the postoperative conjunctival reaction and safeguards against a new corneal ulcer. Occasionally, in patients with marked conjunctival edema and keratinization of a portion of the conjunctiva (Fig. 1c) a permanent lateral tarsorrhaphy is necessary after the orbital decompression.

Through a modified coronal incision, bilateral, narrow, v-shaped bone flaps are turned down, the broad portion of the bone flap being under each temporal muscle as far anteriorly as possible. After the dura is separated from each orbital plate to the sphenoid ridge, the decompression is executed bilaterally by removing the orbital plates anteriorly to the frontal sinuses, medially to the ethmoid sinuses, and posteriorly including each entire sphenoid wing. The optic nerves are uncapped. The lateral portion of each orbital plate is rongeuired completely away inferiorly to the superior and inferior oblique tissues. The orbital periosteum and fascia are then opened widely. In all of our earlier cases the fascia was divided through the annulus of Zinn. It was thought, however, that extra-ocular muscle palsies were increased and therefore in the recent cases this has been left undone. Satisfactory results have been obtained, even if there is a choking of the optic disk, without incising the annular ligament of Zinn.

Immediately on opening the fascia, edematous fat tissue and muscle extrudes. The individual muscles are two or three times their normal size and are grossly firm with a gray appearance. The pathologic sections show round cell infiltration and fragmentation of the muscles, as well as myxedematous changes.

After all bleeding points have been carefully controlled, a generous amount of

sulamyd powder is inserted into the operative wound, the bone flaps are replaced, and the scalp sutured with interrupted

an increase in the extra-ocular muscle palsy probably due to incising the annulus of Zinn.

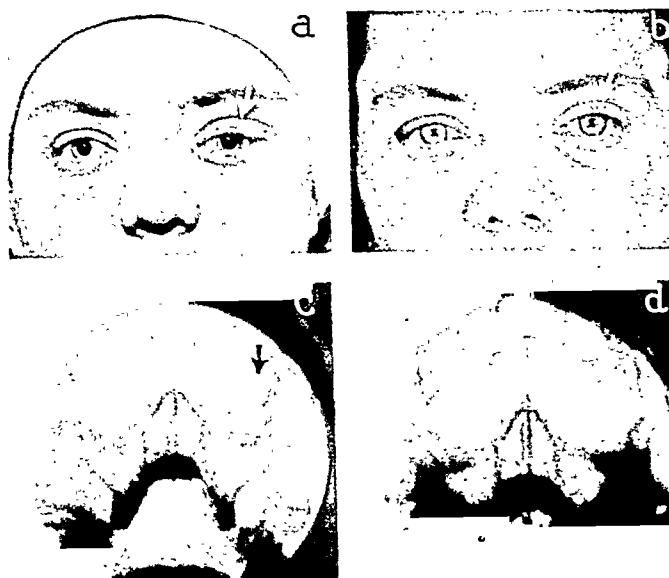


FIG. 11. Cholesteatoma involving the orbit. *a*, unilateral protrusion of eyeball; *b*, postoperative recession; *c*, pre-operative roentgenogram; arrow shows bony defect in the orbit well separated from the frontal sinus; *d*, post-operative roentgenogram.

black silk. Occasionally, small rubber tissue drains are left superficially.

As soon as the operative drapes are removed, the eyes show immediate marked recession and some pulsation. The sutured eyelids are covered generously with White's ointment and moist sea sponges, and by means of an Ace bandage, equal pressure is applied to both eyes.

#### RESULTS

The results of operation have been gratifying in all but two patients. In one of the earlier patients, because of extensive ethmoidal cells extending over the orbital plate, adequate decompression could not be performed. With the sulfa drugs, however, removal of the entire orbital plate including the ethmoidal cells is permissible provided the dura has not been opened. Therefore, possibly the death of this patient who first lost his eyeball because of progressive exophthalmos could have been avoided. In the second patient the eyeballs were saved; however, there was

The degree of regression of exophthalmos was up to 6 mm. during the first year following operation, after which improvement seemed to be more gradual. Extra-ocular palsy, especially convergence, was prevalent preoperatively. Although all general movement returned postoperatively, full function returned in only a few cases. Subjectively, however, the patients were unaware of this. Sixteen patients presented diplopia as a chief complaint, twelve of whom were completely relieved by operation. The disappearance of the double vision was not always immediate but took place after a variable period of time, usually a few weeks to a few months. Nineteen patients showed diminished vision preoperatively, all of whom improved remarkably with the exception of one. Occasionally, optic atrophy from receding papilledema was noted. Three patients had generalized constriction in their fields, and three also showed enlarged blind spots, one of whom likewise presented a right inferior quadrantic field defect. Operation

resulted in some improvement in all these patients with the exception of the one with the field defect.

The presence of corneal ulcers or scars was noted preoperatively in two patients. Four additional ulcers occurred after operation in our earlier cases before lid suturing was performed routinely.

Three patients had marked but temporary frontal lobe symptoms including confusion, disorientation and semiconsciousness which continued for two weeks, four weeks and four days, respectively. These changes undoubtedly were due to retraction on the frontal lobe resulting in postoperative edema; however, in one patient the same reaction occurred following a previous thyroidectomy. There were no operative deaths from the bilateral orbital decompression.

#### COMMENT

There is little to justify allowing a patient to continue conservative measures until it is questionable whether the eyeballs can be saved even by a bilateral orbital decompression. This is particularly true since the mortality in competent hands is negligible, and the results both in saving eyesight and from a cosmetic standpoint are good when the operation is done relatively early. It is of interest to note that our results have improved as our experience has increased. This is due to increasing the extent of the orbital decompression as well as temporary lid suture and postoperative pressure bandages.

Completion of the orbital decompression in one stage saves the patient both mental and physical discomfort.

Even though the recession of the eyeballs following orbital decompression is not dramatic in every case, the fact that the malignant process and loss of vision are arrested makes the procedure worth while. In the decision as to whether an orbital decompression is indicated in a patient with probable progressive exophthalmos, it seems wise to prove definitely by exophthalmometer readings and findings that

the condition is progressive. On the other hand, one should deny a patient an orbital decompression purely from a cosmetic standpoint.

Naffziger<sup>16</sup> should receive all the credit for having both the practical foresight and conviction that decompression of the orbital contents in these patients would save vision as well as eyeballs. It now seems the perfectly obvious procedure.

We have had no occasion to decompress the orbital contents by removal of the walls of the nasal sinuses nor does this seem a procedure of choice from the aseptic standpoint. However, it might be of considerable value in a patient with large sinuses precluding adequate decompression of the orbital tissue in the manner described previously. It seems the better part of valor to complete as extensive an orbital decompression as possible intracranially, and after the intracranial contents are well sealed, perform the sinus operation as described by Kistner.<sup>13</sup>

A point worthy of emphasizing in postoperative treatment is that obesity must be avoided, and if present, treated by diet especially in a patient in whom the orbital fat is abundant at the time of operation. No attempt has been made in our cases to resect the fatty tissue at the time of decompression for fear of increasing or producing extra-ocular muscle palsy.

The other causes of bilateral exophthalmos are rare. Hypertension is described by Ruedeman<sup>23</sup> as causing protrusion of the eyeball up to 8 mm. In his series, no decision concerning treatment was reached due to death of the patients before any serious difficulty with the eyes was experienced. Our only experience with exophthalmos in hypertension has been limited to five cases; four were bilateral and one unilateral occurred in a thirty-two year old woman who during labor developed a sudden, subjective bruit behind the left eye with a rapidly progressive, pulsating exophthalmos on that side. Thoratrast injection of the internal carotid artery demonstrated a typical picture, the dye

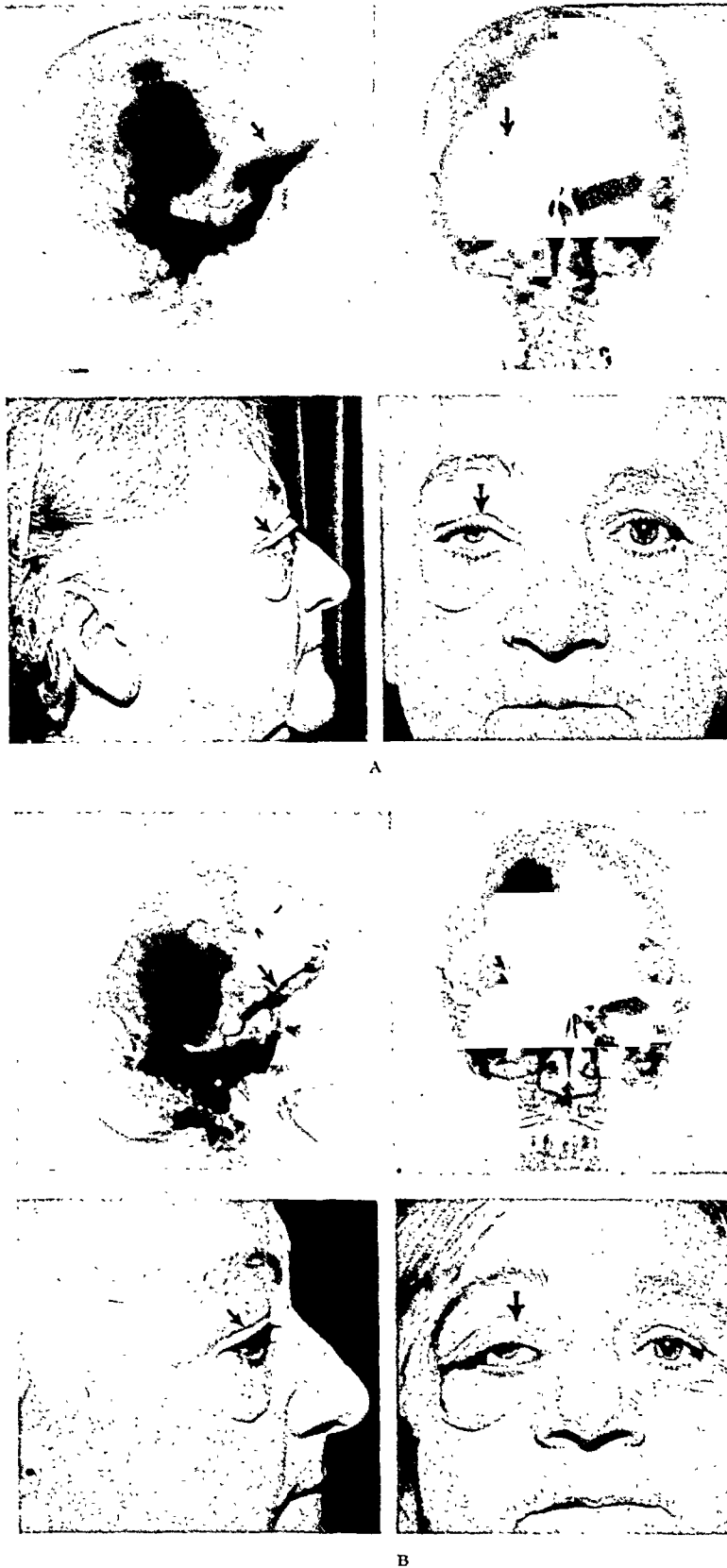


FIG. 12. Hyperostosing sphenoid wing meningioma involving the right orbit. A, preoperative anteroposterior and lateral views, the photographs corresponding with the roentgenograms, demonstrating the unilateral exophthalmos; B, recession following operation.



passing immediately into the jugular vein and not into the cerebral arteries. Ligation of the common carotid artery after ade-

The medical department of the Lahey Clinic has seen two patients who developed exophthalmos without hyperthyroidism



FIG. 13. Left unilateral exophthalmos with downward and lateral displacement of the eyeball typical of osteoma or mucocoele. Large osteoma involving the entire left frontal sinus and portion of the right, displacing the orbit laterally.

quate preoperative occlusion with a light carotid pressure clamp reduced the intensity of the bruit but did not abolish it. One week later a splanchnicectomy was performed with complete subjective as well as objective relief of the bruit. (Fig. 2.)

Increased intracranial pressure of long standing may cause a protrusion of the eyeball due to erosion of the orbital plate, thus allowing direct pressure on the orbital tissue. The most common offenders in producing long standing pressure are benign pinealomas, craniopharyngiomas, colloid cysts of the anterior third ventricle and cranial synosteoses. (Fig. 3.) Paget's disease may cause bilateral protrusion of the eyeball because of a decrease in the size of the orbital cavity due to proliferation of bone.

by the prolonged use of thyroid extract for obesity, and one who developed exophthalmic goiter (6 to 9 gr. of thyroid extract daily for five to six years).

#### UNILATERAL EXOPHTHALMOS

The differential diagnosis of unilateral exophthalmos usually is not difficult; however, the patient's history may be inaccurate as to the duration of the exophthalmos especially in the gradually progressive, subjectively symptomless type, in which the patient notices the exophthalmos only when local symptoms such as gradual visual changes, pain or headache occur. As in all diseases, the frequency of the etiologic factors must be kept in mind and play a part in the tentative diagnosis. For that reason, a table of conditions causing

unilateral exophthalmos in forty-one cases encountered in the last nine years is given. (Table II.) It is of interest to note that not one patient with Schüller-Christian disease was encountered, whereas Dandy<sup>s</sup> in his series of orbital tumors found it to be the most prevalent.

TABLE II	
UNILATERAL EXOPHTHALMOS	
Etiologic Factors, Forty-one Cases, 1933-1943	
Sphenoid wing meningioma.....	11
Meningioma involving frontal bone and orbital plate.....	1
Carcinoma {metastatic.....	2
{primary nasal sinus.....	1
Sarcoma {osteogenic.....	1
{neurogenic.....	1
Cholesteatoma.....	3
Osteoma.....	3
Glioma of optic nerve.....	2
Cavernous sinus thrombosis.....	2
Aneurysm {internal carotid.....	1
{arteriovenous.....	1
Angioma {venous (orbital varicosity).....	1
{racemose.....	1
Mixed tumor of lacrimal gland.....	1
Pseudotumor.....	1
Mucocele.....	1
Orbital abscess.....	1
Osteomyelitis {pyogenic.....	1
{tuberculous.....	1
{syphilitic.....	1
Chronic infection of lacrimal gland.....	1
Hematoma of orbital tissues.....	1
Neurofibroma.....	1

Statistics, therefore, in a relatively uncommon condition cannot be used as an accurate guide in diagnosis; nevertheless if one is familiar with the possible causes, the ultimate accurate diagnosis can be made more quickly and may serve to save a patient's vision, distressing deformity and even life.

Sudden or acutely developing exophthalmos usually is associated with severe discomfort. This occurrence immediately excludes the more favorable types of tumor amenable to surgical removal. Localized infection of the orbital tissues can be recognized by the extreme tenderness of the orbital tissues to pressure, pain on attempt to move the eyeball, increased local and systemic temperature, and a history of recent infection elsewhere in the body, usually involving the face or nasal sinuses. A cavernous sinus thrombosis can be dif-

ferentiated from the localized infection of the orbital tissues by the extreme malaise, hyperpyrexia, complete ophthalmoplegia, and usually a complete third nerve paralysis. The arteriovenous aneurysm also comes on rapidly, and may be associated with considerable pain and tenderness locally around the affected eye. However, the patient is aware of a bruit synchronous with his pulse, and this also usually can be readily verified by auscultation, and the bruit can be diminished or completely abolished by digital compression of the internal carotid artery on the affected side. Many times pulsations of the eyeball can be seen. In the early stage the engorgement of the vessels is marked; however, because of the extreme chemosis of the conjunctiva that develops, this factor may be obscured. In the patient with arteriovenous aneurysm the pulse rate is usually increased. Arterial blood can be collected from the jugular vein. The usual roentgenograms of the skull may be normal; however, special arteriograms of the internal carotid artery demonstrate a characteristic defect and are characterized by the fact that only the internal carotid artery fills up to the fistulous tract and immediately empties into the internal jugular vein through the cavernous sinus, and for that reason, incomplete filling of the cerebral arteries takes place.

A hematoma formation in the orbital tissues, of course, can be identified readily since there is either a history of injury or blood dyscrasia, and the ecchymosis that develops in the upper and lower eyelids immediately verifies the diagnosis. Aneurysm of the internal carotid artery with erosion of the sphenoid wing and orbital plate with direct pressure on the orbital tissues can be recognized by roentgenograms of the skull with special attention to the orbit and sphenoid wing or by arteriograms.

The intermittent type of exophthalmos caused by the so-called "varicosities of the orbit" or venous angioma are dramatic in that there is a rapid protrusion of the

eyeball whenever the head is lowered beneath the heart level and practically a complete recession within a few seconds after the head is in the upright position. Eagleton<sup>10</sup> states they occur ten times more frequently on the left side than on the right. Reese<sup>21</sup> believes this may be due to the fact that the jugular foramen is usually smaller on the left side. (Fig. 4.)

Osteomyelitis producing exophthalmos may be due to syphilis, tuberculosis or pyogenic infection. The roentgenograms are usually characteristic. The favorite site of syphilis is the superior orbital rim. Tuberculous osteomyelitis is rare, but is usually primary in the nasal sinuses. (Fig. 5.) In some cases the differential diagnosis can be made only by biopsy except, of course, in the syphilitic types in which the blood serology is of utmost importance.

Carcinoma of the retro-orbital tissues is usually metastatic; however, it may be primary in the nasopharynx. Roentgenograms are of diagnostic value only when the carcinoma has invaded bone.

The osteogenic sarcoma may be recognized readily by the roentgenologic findings, whereas the neurogenic sarcoma (neurofibrosarcoma) can be differentiated from a neurofibroma only microscopically. (Figs. 6, 7, 8 and 9.)

The cholesteatoma, hyperostosing sphenoid wing meningioma and osteoma of the frontal sinus have characteristic roentgenologic findings, as demonstrated in Figures 10, 11 and 12. The osteoma and mucocele usually may be differentiated from the hyperostosing sphenoid wing meningioma by local examination. In the former two, the eyeball usually is depressed laterally with a fullness under the upper eyelid, whereas in the latter the eyeball usually is protruded in the midline with varying degrees of depression and a fullness of the temporal area on the affected side when compared with the opposite side. Early optic atrophy occurs in hyperostosing sphenoid wing meningioma. Usually little impairment of extra-ocular movement occurs in either condition until a

marked degree of exophthalmos has developed, whereas in all the malignant orbital tumors and infections an early limitation of ocular movement is present. Pressure on the eyeball through the closed eyelids during examination is of value since in all orbital new growths a definite sense of resistance can be detected.

A glioma of the optic nerve must be suspected in early unilateral visual changes and characteristic changes in the optic disk by ophthalmoscopic examination. Roentgenograms of the optic foramina are of considerable value and many times establish the diagnosis. Roentgenograms of the optic foramina should be taken in all patients with unilateral exophthalmos in whom the diagnosis is not evident immediately from the history, neurologic examination or the usual roentgenograms of the skull.

#### TREATMENT

The treatment of the hyperostosing sphenoid wing meningioma, which has been described previously,<sup>20</sup> is entirely surgical.

The osteoma and mucocele may be removed satisfactorily and with gratifying cosmetic results either transcranially through a small frontal bone flap or by a direct attack on the frontal sinus.

The arteriovenous aneurysm may need both extracranial as well as intracranial operations, as described by Dandy.<sup>7,9</sup> In three cases Adson<sup>1</sup> found it necessary to ligate the common internal and external carotid arteries cervically as well as do an intracranial occlusion of the internal carotid artery before it branched and ligated the ophthalmic vein, also resecting portions of the peri-orbital vein before satisfactory results were obtained. Adson found that no visual changes resulted from ligation of the ophthalmic vessels. If an arteriovenous aneurysm occurs in a patient with hypertension whose study demonstrates suitability for sympathetic surgery, he may have to be subjected to a combination of operations before a satisfactory result can be obtained. Preceding ligation of the internal carotid artery, it is of importance

to be certain that a hyperirritable carotid sinus is not present, for prolonged stimulation of the sinus might cause death at the time of operation. In preparing the patient for ligation of the artery, it is the practice to accustom him to occlusion of the artery by either digital compression or special clamps such as described by Light.<sup>14</sup> It is well, therefore, to start initial occlusion of the internal carotid artery cautiously with digital compression. If slowing of the pulse or syncope does not develop, it is safe gradually to increase the occlusion to thirty minutes three times daily before ligation is carried out. At the time of ligation cerebral ischemia should be prevented by keeping the blood pressure normal and the head below the heart level, continuing this for at least two postoperative days.

Carcinoma should usually be treated by roentgen therapy. At times, however, surgery may be used as a supplementary measure.

Sarcoma of neurogenic origin responds very little to roentgen therapy, and local excision transcranially is indicated. This is also true of the osteogenic sarcoma; however, roentgen therapy should supplement the excision.

The treatment of angioma depends on its extent. The arterial orbital angioma is usually encapsulated and can be removed safely and readily transcranially. The venous angioma should be removed transcranially by electrosurgery. The lymphangioma usually is associated with such extensive peri-orbital involvement that surgical treatment is not feasible, radium or roentgen therapy being the treatment of choice.

#### SUMMARY

A survey of the etiologic factors causing either bilateral or unilateral exophthalmos is given with a discussion of their management and results.

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# GANGRENE OF THE FINGER FOLLOWING DIGITAL NERVE BLOCK

## A REPORT OF EIGHT CASES WITH DISCUSSION OF THE GANGRENE PATHOGENESIS

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A DIGITAL nerve block with a local anesthetic solution is frequently used for the performance of minor surgical operations upon the fingers. The most popular anesthetic solution is 1 or 2 per cent procaine, with or without epinephrine. A skin wheal is raised on the dorsum of the base of the finger by injecting several drops of the anesthetic solution into the skin with a small calibre hypodermic needle. Through this wheal, the needle is inserted along the side of the phalanx and several cc. of the anesthetic solution are injected as the needle advances. The needle is withdrawn, and using the same skin wheal or a new one, the other side of the phalanx is injected. A tourniquet is often placed around the base of the finger in order to obtain a more rapid anesthesia. This technic is demonstrated in Figure 1.

Digital gangrene following the above type of nerve block has been reported very infrequently in the English literature. Garlock<sup>1</sup> first called attention to this complication in 1931 in a series of four cases. Kaufman,<sup>2</sup> in 1941, reported another case and reviewed the literature very completely. He called attention to the fact that this type of gangrene was frequently reported in the German and French literature. Since this time, two more cases have been reported by McLaughlin<sup>3</sup> and Perner.<sup>4</sup> Altogether, thirty-two cases have been cited in the combined English and foreign literature. This would lead one to the conclusion that such gangrene is a very infrequent complication of digital nerve block. To prove that such is not the case, the following series of eight cases is reported

and discussed. Table 1 presents a summary of these cases.

### CASE REPORTS

CASE I. M. K., a forty year old white married woman entered the Out-patient Department on May 9, 1938, with a localized abscess at the tip of her right index finger. A nerve block was performed and the abscess was incised. On returning home, she placed the finger in hot water. On the next day the finger became very swollen, and two days later large blebs were noted over the entire finger. These were débrided. The finger became worse and in about eight days the distal third of the finger was dark brown and anesthetic. The patient was admitted to the house on May 24, 1938, and warm soaks were applied to the finger. On June 1, 1938, under gas-ether anesthesia, the finger was amputated at the base of the gangrenous area, at the distal end of the proximal phalanx. The subsequent course was uneventful.

CASE II. S. S., a forty-one year old colored widow entered the Out-patient Department on August 2, 1935, with a paronychia of the right mid-finger. Nerve block anesthesia was performed at the base of the finger with novocain solution (? adrenalin). No tourniquet was used. The finger was incised and the patient went home and soaked her finger in warm water which "did not feel extremely hot." Following this in the morning, the finger began to swell to "twice its size" and the next day blebs appeared on the finger. Gentian violet ointment was then applied to the finger which gradually became worse with sloughing of the skin and subcutaneous tissue. The patient was admitted to the house on September 3, 1935, where the distal phalanx was found to be dry and shriveled and numb. On September 7, 1935, under ether anesthesia, an amputa-

tion was performed through the proximal phalanx. The subsequent course was uneventful.

CASE III. L. A., a fifty-one year old Italian housewife entered the hospital on August 28, 1941, with a laceration over the distal interphalangeal joint on the palmar aspect, and a fracture of the middle phalanx. The laceration was about 1½ cm. long. A digital block was performed with 15 cc. of 2 per cent novocain

tered again on September 10, 1938, with a chronic paronychia of the right index finger. On September 13, 1938, the base of the nail was removed under local nerve block. While the finger was still numb, she placed it in very hot water. The next day, "extensive burns" were noted over the entire index finger. On September 23rd, the patient was complaining of considerable pain in the finger and the

TABLE I  
SUMMARY OF EIGHT CASES OF FINGER GANGRENE FOLLOWING DIGITAL NERVE BLOCK

Case	Sex	Age	Complaint	Amount Sol.	Epi-neph-rine	Tour-niquet	Soaks	Result
I	F	40	Localized small abscess-tip of rt. index finger	?	?	?	Hot water	Finger swollen next day with blebs. Distal third became black and atrophied. Amputation.
II	F	41	Paronychia rt. mid-finger	?	?	o	Warm water	Finger began to swell that night. Distal third became black and shriveled. Amputation.
III	F	51	Laceration distal interphalangeal jt. Fracture middle phalanx.	15 c.c.	o	o	.....	Distal end became black and necrotic. Amputation.
IV	F	56	Paronychia rt. index finger.	?	?	?	Very hot water	Next day—extensive burns over entire finger. Distal portion became black and atrophied.
V	F	47	Infected splinter wound	?	?	+	.....	Severe pain in the evening. Blebs and swelling next day. Distal half became black and hard.
VI	F	62	Paronychia rt. middle finger	4 c.c.	+	o	Comfortably warm water	Finger swollen and cyanotic next day. Distal phalanx became black. Amputation.
VII	F	42	Paronychia left mid-finger	?	+	o	Very hot	Finger swollen next morning. Distal half became black but in about a month, only terminal 1-2 cm. were lost.
VIII	M	59	Subungual hematoma left thumb.	?	?	?	Hot	Finger became swollen with blisters. Distal half turned black and atrophied. Amputation.

solution without adrenalin. The laceration was irrigated and sutured. Six days later the entire finger was found to be swollen and the distal end was black and necrotic. The condition was treated with warm soaks. The patient refused amputation. On October 10, 1941, under pentothal anesthesia, amputation was performed through the mid-portion of the proximal phalanx. The subsequent course was uneventful.

CASE IV. L. C., a fifty-six year old Jewish lady entered the Out-patient Department on August 15, 1938, with onychia of the right index finger. This was incised under nerve block anesthesia and it healed well. She en-

distal portion was atrophied. She was admitted to the house on September 26, 1938, when the distal three fourths of the finger was found to be atrophied and black with the proximal portion red, swollen and tender. She was returned to the Out-patient Department for further treatment of the sepsis prior to amputation. The subsequent course is not known.

CASE V. A. S., a forty-seven year old white, married female had tuberculosis in 1916 and went to a sanitarium for one year. On November 7, 1939, the patient received a splinter in her right fifth finger which she removed herself. However, the finger became painful and one week later a nerve block with novocain was

performed, using an elastic band for a tourniquet. The operation of incision and drainage lasted about three quarters of an hour. The

patient was admitted to the house on February 8, 1943, where the finger was found to be "slightly swollen with a broken blister

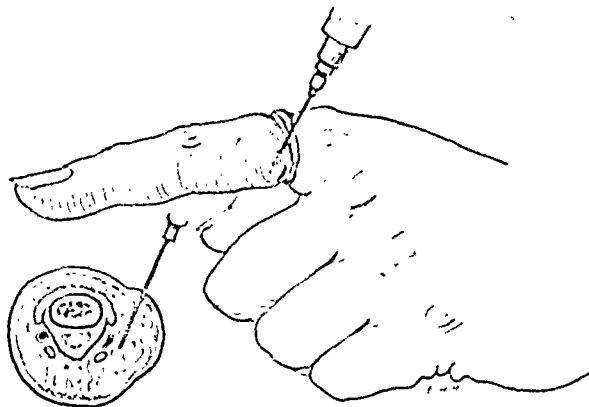


FIG. 1. A popular digital nerve block technic, demonstrating use of tourniquet. Cross section shows how digital artery may be compressed by the injected anesthetic solution.

patient suffered severe pain in that finger for the rest of the day and night. The next day, soaks were advised but the pain continued. The following day, the dressing was removed and numerous blisters were noted on the finger. These were opened and the finger was redressed. The pain continued and the patient entered the hospital on November 11, 1939. The distal phalanx plus one-half of the middle phalanx was "definitely black in appearance" and anesthetic. Demarcation continued and on December 2, 1939, the patient was discharged to the Out-patient Department for treatment of the finger prior to amputation. The patient was readmitted on May 6, 1940, when the proximal phalanx was black and hard. Amputation through the middle phalanx was performed and the subsequent course was uneventful.

CASE VI. C. D., a sixty-two year old lady entered the Out-patient Department on February 5, 1943, with a paronychia of her right middle finger which was incised under nerve block, using 4 cc. of a 2 per cent novocain-adrenalin solution with no tourniquet. She went home and soaked her finger in very warm water. This water was "comfortably warm." This procedure was done several times during the day. The next day she noticed the finger was swollen and very dark red and she returned to the Out-patient Department. Warm chlorinated soaks were continued but the finger became more swollen and blistered. The

extending from the tip to the proximal portion of the middle phalanx." "The distal phalanx was black." The finger gradually began to demarcate at the center of the middle phalanx. (Fig. 2.) On February 29th, the terminal portion was hard, black and shriveled around the bone. On March 10, 1943, amputation was performed. A skin test with adrenalin and novocain on March 14th, revealed no abnormal sensitivity to these agents.

CASE VII. M. K., a forty-two year old white widow entered the Out-patient Department on January 15, 1943, with a paronychia of the left mid-finger which was incised and drained under nerve-block anesthesia, with novocain-adrenalin solution of an unspecified quantity. No tourniquet was used. The patient went home and, while the finger was still anesthetic, placed the entire hand in water "as hot as she could stand" for twenty minutes. This was continued every two hours for five soakings. The next morning, when the bandage was removed, the entire finger was swollen and the skin of the distal half was black. The finger was very painful. The rest of the hand was normal, with no erythema. The finger remained swollen and black for about a month and was treated with chlorinated soaks. Finally, the swelling subsided and the color became more normal until March 19, 1943, when there was a 2 cm. area of sloughing skin and subcutaneous tissue at the tip of the finger. The finger has motion of about 5 degrees in each joint

and the subcutaneous tissue of the entire digit is very much atrophied.

CASE VIII. J. O'C., a fifty-nine year old white male entered the Out-patient Department on November 6, 1935, with a subungual hematoma. Under novocain nerve-block anesthesia, this was incised and hot soaks were applied to the finger. The finger became swollen and numerous blisters appeared. In about a week, the distal half turned black and the patient was admitted to the house. On entry (December 5, 1935), he presented "hard, cold two distal phalanges of the left thumb." By December 25, 1935, the "end of the finger was cold, decreasing in size and the bone was visible." On January 1, 1936, under gas-oxygen-ether anesthesia, the terminal phalanx was amputated. Incidentally, this case in the Out-patient Department was treated with Gentian violet ointment following the discovery of the blisters and on entry the finger had an eschar around it.

#### COMMENTS

Gangrene of the fingers following nerve block is due either to a severe thermal damage which causes an irreparable tissue necrosis, or to a circulatory deficiency. Lambert and Snyers<sup>5</sup> believe that a third factor is at work, i.e., thrombophlebitis of the digital veins with secondary retrograde arterial obliteration, probably due to arterial spasm. They based their conclusion on the fact that edema and cyanosis, with no ensuing gangrene, follows local infiltration of novocain in experimental studies on a man's finger and on rabbits' ears. Such edema they attribute to venous stasis and not to arterial occlusion. However, if the circulation to a part is obliterated for a time, sufficient to cause capillary damage, severe edema and cyanosis will follow release of the obliteration as the blood flows through the damaged capillaries.<sup>6,7,8</sup> Pochin<sup>38</sup> investigated the edema produced in rabbit's ears by temporary ischemia and found the edema fluid to be rich in protein. Injection of Evans blue dye into the rabbits, prior to removal of the occlusion to the ear, resulted in the affected ears becoming blue as well as edematous. Samples of edema fluid were

deeply colored. Both these findings demonstrate increased capillary permeability following ischemia.



FIG. 2. Digital gangrene following nerve block with 2 cc. of a novocain-adrenalin solution. Case VI.

There is thus no need for assuming that venous thrombosis must be present. Therefore, only factors relating to circulatory deficiency and thermal damage will be mentioned in this discussion.

#### CIRCULATORY DEFICIENCY

*Epinephrine.* The presence of vaso-constricting epinephrine in the anesthetic solution has been suspected of being a major factor in the development of the gangrene. Gangrene of other areas of the body following the local use of procaine-adrenalin solutions have been reported: abdominal wall (Gebele,<sup>10</sup> Koch<sup>11</sup>), scrotum (de Smeth<sup>12</sup>) and patella (Boerner,<sup>13</sup> Wagner<sup>14</sup>). In finger gangrene following digital nerve block, Kaufman<sup>2</sup> found it was used in 75 per cent of the cases in which its presence or absence could be determined. Pelner<sup>1</sup> and McLaughlin<sup>3</sup> reported its use in each of their cases. In this series, the presence or absence of the adrenalin in the anesthetic solution was determined in only three cases and in two of these, adrenalin was used (Cases VI and VII). However, the routine solution of novocain that is used in our Out-patient Department is 2 per cent novocain-epinephrine



solution and it may probably be correctly assumed that the majority, if not all, of the other cases was infiltrated with the novocain-epinephrine mixture.

adrenalin may cause an exaggerated response to the vasoconstrictor substance (Heinicke<sup>13</sup>). However, cutaneous tests by Makai<sup>14</sup> and Kaufman<sup>2</sup> were negative and,

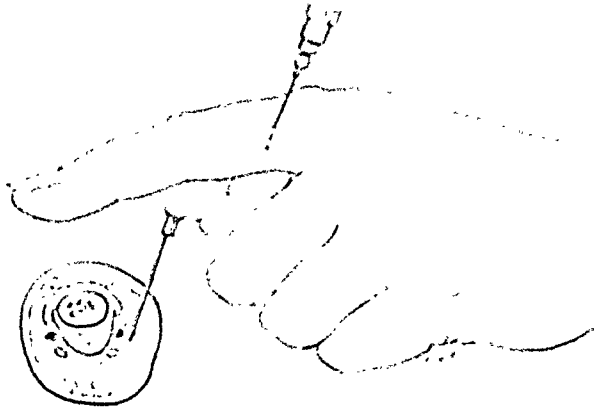


FIG. 3. Demonstration of nerve block using only 1 to 1½ cc. of anesthetic solution without adrenalin or use of tourniquet. Cross section shows that this amount of fluid should not compress digital artery.

Several animal experiments have been performed in order to throw some light on this question. Lambert and Snyers<sup>3</sup> sectioned rabbits' ears lengthwise so that each long segment had a nourishing artery. When the ears had healed, their bases were infiltrated with scurocaine solutions of various strengths, and with or without adrenalin. They found that in several hours the various segments became edematous and cyanotic, whether or not adrenalin was used. From the brief report of their experiment, it appears that the adrenalin may have produced more capillary anoxia, since the edema disappeared in twenty-four hours when 2 per cent scurocaine without adrenalin was used, and in forty-eight hours when adrenalin was used. Pelner<sup>4</sup> injected the bases of rats' tails with 1 cc. of procaine, or normal saline, with and without various concentrations of adrenalin, and found that gangrene of these tails never developed unless adrenalin was used, even if the concentration was as low as 1:100,000.

The majority of patients who receive procaine-epinephrine nerve block do not develop gangrene. Therefore, some observers believe that a hypersensitivity to

in Case VI of this series, a cutaneous test with 1:1,000 epinephrine solution revealed no abnormal sensitivity.

Cammer and Griffith<sup>15</sup> have suggested that adrenalin may have an effect on local tissues other than vasoconstriction. These authors have some experimental evidence to indicate that adrenalin decreases the oxygen utilization of tissues. Although this decrease is probably secondary to vasoconstriction, further investigation of this local tissue effect is indicated.

Thus there is good clinical evidence and some experimental evidence that the use of adrenalin in the anesthetic solution may cause sufficient vasoconstriction to produce gangrene. However, it must be remembered that procaine-adrenalin solutions are the most commonly employed. Hence accidents following their use should be reported more frequently. Besides, cases have been reported in which no adrenalin has been used (Siebert,<sup>18</sup> Moulounguet,<sup>19</sup> Delgoffe,<sup>20</sup> Dejardin<sup>21</sup>) and none was used in Case III of this series. Thus some other factors must be operating.

**Tourniquets.** Garlock was one of the first to attribute the digital gangrene to the use of a tourniquet at the base of the

finger. The tourniquet is dangerous because it markedly slows down the blood supply to the finger and produces local tissue damage at the site of the compression, thereby favoring arterial thrombosis. Garlock presented four such cases.<sup>1</sup> Individual cases of a tourniquet being used with subsequent gangrene have also been reported by Siebert,<sup>18</sup> Makai,<sup>16</sup> Lambert and Snyers<sup>5</sup> and McLaughlin.<sup>3</sup> In this series it was used in one of three cases in which its presence could be determined (Case v). Thus, the danger of using a tourniquet in such nerve block anesthesia is fairly well established.

*Injected Fluid Mass.* The subcutaneous tissue is not very spacious. It is easily apparent, from a glance at Figure 1, that even a few cc. of fluid will distend this space and hence compress the digital vessels. In some cases (Wolfsohn,<sup>22</sup> Rupp,<sup>23</sup> Delgoffe<sup>20</sup>) from 8 to 15 cc. of solution were injected around the base of the fingers. In Case III of this series, 15 cc. of novocain solution without adrenalin was used. Attempts have been made to obviate this lack of space by injecting the solution at different levels of the finger or between the metacarpal bones. However, gangrene has also followed this practice.<sup>15, 24</sup>

Experimentally, edema and cyanosis followed the use of any fluid injected in Lambert and Snyers' experiments on the rabbits' ears.<sup>5</sup>

Thus, the mere presence of fluid at the base of the finger may interfere with the blood supply especially if used in large amounts or if used in patients with poor blood supply, such as older people with arteriosclerosis. Therefore, in performing the nerve block, only 1 to 1½ cc. of solution should be injected. This is demonstrated in Figure 3.

*Miscellaneous Factors.* It may happen that the digital arteries or veins may be severed with the hypodermic needle or injected with the needle and produce a thrombosis. No cases, however, have been found to demonstrate this.

In Case VIII of this series, the patient on

entry to the hospital presented a finger with an eschar around it formed by Gentian violet ointment. This eschar may have embarrassed the circulation and, therefore, aided in the initiation of gangrene.

#### THERMAL DAMAGE

Upon studying the case histories of the patients with gangrenous fingers, it was discovered that warm or hot soaks had been applied to a great many of the cases. Since many of these fingers have been described as having severe burns, these soaks may have played a rôle in the gangrene production.

*Very Hot Soaks.* Temperature above 47°C. causes heat coagulation in the mammalian muscle (Allen<sup>8</sup>). Therefore, exposure of finger to heat above this level may be unfavorable. A finger placed in water at a scalding temperature (60° to 80°C.) will undergo severe tissue damage and may go on to gangrene even if there is normal digital circulation. Since the patient would ordinarily withdraw the finger from such a hot solution, this situation could occur only if the finger were still anesthetized. This probably occurred in the cases of McLaughlin,<sup>3</sup> Halla,<sup>25</sup> and Kaufman.<sup>2</sup> It may have occurred in Case IV of this series.

*Hot Soaks.* Fingers exposed to a temperature above 47°C. but below the scalding level are normally not damaged. This is the temperature of water which is subjectively described as "hot as one can stand." However, if there is a disturbance in the digital circulation so that the heat is not carried away from the finger, the normal temperature control is disturbed and the digital tissues would approach the level of their environment in proportion to the amount of circulatory embarrassment present. Schwan<sup>26</sup> reported a case of a finger with a contracture deformity which was subjected to novocain digital nerve block and subsequent dry heat. That night a black swelling occurred in the region of the injection which went on to gangrene and sloughing. This instigated an experi-

ment by I. Farben, in which rabbits' ears were subjected to a dry heat at above 60°C. In one series the bases of the ears were injected with several cc. of 2 per cent novocain, and in the other series no injections were made. Severe edema with ensuing gangrene always occurred in the injected ears. It is evident that in the non-injected ear, the circulation was sufficient to maintain the temperature of the tissues at a normal level, whereas in the injected ears, the disturbance in circulation prevented such temperature control and permitted the tissues to approach that of the surrounding air. Starr<sup>27</sup> reports similar experiences in legs, with arteriosclerotic occlusion, exposed to a heat cradle. Such a mechanism may have been present in Cases I, VI, and VII. The last case (Case VII) presents an experiment almost identical with Schwan's animal experiment. This patient soaked her entire hand in water "as hot as she could stand" for twenty minutes while the finger was still anesthetized. No change (erythema, vesicles, pain) occurred in the non-anesthetized digits, but the injected finger became swollen and black and the patient was extremely fortunate not to have lost the entire digit.

**Warm Soaks.** Temperature between 0°C., where freezing occurs, and 4°C., where coagulation occurs, affects tissues in several ways. First, it changes the blood flow to the affected part. Hewlett and van Zwaluwenburg,<sup>28</sup> by means of the plethysmograph, demonstrated that elevation of temperature to the body as a whole, produced increased circulation to an extremity, whereas cooling definitely decreased the circulation. This has been demonstrated several times since by Stewart,<sup>29</sup> Freeman<sup>9</sup> and Kunkel and Stead.<sup>30</sup> Second, increased temperature increases the metabolic rate of a tissue by speeding up the velocity of the tissue chemical reactions.<sup>31-33</sup> Thus, when heat is supplied to a tissue, the tissue metabolism is increased and the circulation is also increased to meet the metabolic needs.

If, however, there is some obstruction to the circulation, metabolism will rise in excess of the circulation and the demand for oxygen and food and removal of waste products will be more than can be met by the circulation, and gangrene will result.<sup>33</sup>

Allen<sup>6,7,8,32</sup> was the first to face this problem experimentally. By ligating limbs and intestines of animals and exposing them to various temperatures, he found that slight elevations of temperature increased the incidence and onset of gangrene remarkably. Brooks and Duncan<sup>34</sup> reported similar experiments. When one considers that the high temperatures in Allen's and Brooks and Duncan's experiments which led to early gangrene were approximately 40° to 45°C., really that of comfortable warm water and below the critical muscle coagulation temperature, one wonders whether such factors enter into the pathogenesis of digital gangrene, following interference with the circulation due to the nerve block. Allen has noted the severe destructive changes caused by slight elevations of temperature. "The appearances rather strikingly resemble ordinary burns; particularly, the erythema, vesication and necrosis of limbs asphyxiated for a short time a little above 40°C. give an appearance which is scarcely distinguished from that of limbs dipped briefly into boiling water."<sup>35</sup> Thus, this increase in the digital tissue metabolism, in fingers with the circulation impaired by the novocain block, may lead to severe tissue damage and gangrene.

#### SUMMARY AND CONCLUSIONS

Eight cases of gangrene of the finger following digital nerve block are reported in order to demonstrate that this complication is not so infrequent as perusal of the literature would indicate. The pathogenesis of this complication has been discussed. It has been found that the injected solution may interfere with the digital circulation and produce gangrene, if first, too much solution is used, or second, if epinephrine is present in the solution or, third, if tourniquets are used. If the damage to the

circulation is not sufficient in itself to produce the gangrene, subsequent soaking of the finger in hot or even warm water may hasten devitalization of the tissue.

It is suggested that digital nerve block be replaced whenever possible by a general anesthesia using pentothal or gas-oxygen or ether. If it becomes necessary to use a local anesthesia, great care should be taken in performing the nerve block. No tourniquet nor solution containing adrenalin should be used. Only a small quantity of solution should be used, i.e., about 1 to 1½ cc. for the entire block. Soaks should be contraindicated for at least twenty-four hours.

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# CHANGING CONCEPTS OF INGUINAL HERNIA

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INGUINAL hernia is probably one of the oldest lesions known to man, having been portrayed in the ancient art of Egypt and Greece. It is, therefore, quite natural that in the long ensuing span of time, viewpoints of the various phases of the subject should have gone through numerous cycles of interpretation. There are several reasons to account for this: (1) Misunderstood pathogenesis, (2) anatomical-physiological ignorance, (3) large percentage of postoperative recurrence, and (4) failure to recognize and apply the logical principles of treatment.

## MISUNDERSTOOD PATHOGENESIS

The word "hernia" is derived from the Greek term meaning a branch or outgrowth, the ancients' conception of hernia. In the middle ages this belief was displaced by the one which considered hernia as a rupture or "*Bruch*" of some of the retaining structures, thus implying that all inguinal hernias were acquired. Later on, as the descent of the testicle was correlated with the potential causation, only those hernias were considered congenital in which the sac was part of, and continuous with the tunica vaginalis. The other types recognized were the encysted or infantile form and a hernia into the funicular process. This latter was the result of failure of closure of the upper pole of the tunica. The encysted form was the result of an additional attachment of the gubernaculum to that part of the peritoneum lying below and posterior to the peritoneum which normally forms the future tunica. Thus an additional pouch of the peritoneum is drawn down and eventually becomes encysted posterior to the true processus vaginalis. In case of operation, three distinct layers of peritoneum would have to be

incised before entering the true hernial sac with its contents. This form must be very rare, very few being reported in the contemporaneous literature. It remained for the modern era to cut the Gordian Knot by considering all indirect inguinal hernias congenital at least as far as the sac is concerned, but with the understanding that a hernia is not considered such unless it contains abdominal contents. This might at first appear to be straddling the question were it not the only means of coordinating the concept of congenital origin with the question of trauma and compensability, which latter is such an important economic factor in our modern mechanical age; although it must be parenthetically stated that some compensation boards refuse to take this attitude and thus disallow compensation for hernia.

## ANATOMICAL-PHYSIOLOGICAL IGNORANCE

Although an indirect inguinal hernia must first leave the abdomen through the deep ring, the latter is rarely evaluated and only occasionally dealt with operatively, irrespective of its large dimensions. On the other hand, an increased size of the superficial ring is stressed and pointed out as more important. In fact a large superficial ring through which an impulse on coughing may be felt has been considered a positive or potential hernia. Nothing is further from the truth. An impulse is always obtainable in every normal individual. Furthermore, a large diameter of the superficial ring does not favor the existence of a hernia any more than a large mouth will permit more food to pass down into the esophagus.

The embryological development, variations and trap-door function of the internal

oblique muscle has rarely been touched upon and only lately is being recognized. In the author's opinion, the proximity of this muscle to, and its defense of the deep ring is as important a factor as the persistent processus vaginalis. Even if the latter is patent and the deep ring moderately large, as long as the muscle is competent to act as a trap-door and thus prevent the abdominal contents from entering the ready made sac, no hernia will or can exist. Only the final and complete incompetency can explain the fact that two or three decades may intervene between birth and the first appearance of an indirect inguinal hernia.

Another structure, formerly neglected completely, has in the last few years been considered of major importance, viz., the transversalis fascia. Possibly the fact that it is covered by areolar tissue and that its strongest fibers lie posterior to the internal oblique muscle have been the causes of its neglect. Its cephalad portion, constituting the internal ring, and the caudad portion are of prime importance in the indirect and direct type, respectively.

The concept of the pathogenesis of direct inguinal hernia has remained more stable; it has been and still is acknowledged as an acquired lesion. The older anatomists stressed the fact of the division of the peritoneum in this region into three distinct fossae, any one of which could be a possible weakness and site of hernial origin. The boundaries of these are in the mid-line, the urachus, more laterally the obliterated hypogastric, and most laterally the deep epigastric vessels. A hernia through the middle of these was considered capable of emerging through the separated fibers of the conjoined tendon. This seems so improbable as to lead one to believe that the most caudad portion of the internal oblique muscle was erroneously mistaken and misnamed conjoined tendon. These two anatomical terms are still very loosely used in many operating rooms. But it must be remembered that the length of the conjoined tendon rarely exceeds three-quarters of an inch.

An anatomical enigma has been the proportion of one to four of direct to indirect primary hernias, inasmuch as Hasselbach's triangle, the site of the direct hernia is practically unprotected except by peritoneum and transversalis fascia. Equally inexplicable is the fact that postoperative recurrences appear much more frequently as the direct form even though the primary hernia had been of the indirect congenital type. Failure to recognize and thus traumatize the transversalis fascia at the primary operation may be a factor.

Though not generally recognized, there are two clinical-anatomical varieties of direct hernia: The one, the commoner, results from an attenuation and stretching of the overlying transversalis fascia; the other is represented by the extrusion of a definite pyriform sac through an artificial opening in this fascia. The practical significance of this differentiation lies in the fact that the former, never becoming strangulated, need not be operated; while the latter may and does become incarcerated and, therefore, must be operated upon.

#### RECURRENCE AND ILLOGICAL TREATMENT

It is reasonable to expect that in our present era of surgical progress one, two or at most three operative procedures have been generally approved and accepted. On the contrary more and more types and modifications of operations have been added to the unwieldy total. The foremost cause of this must be the high percentage of operative failures, much higher than generally believed and reported. The laity also knowing of this, could not be blamed for vainly grasping at a method (injection) portrayed so enthusiastically without the added discomfort and economic hindrance of hospitalization. In the pre-Pasteur days infection at operation was quite a common occurrence. Laudable pus was given credit for the formation of fibrous tissue which was considered the main factor in those cases which remained free of recurrence. In fact, one famous surgeon (McBurney)

packed all his hernia operations wide open with this in mind. But he abandoned this method as he recognized its fallacy very soon. The injection treatment is based upon this same fact of fibrous tissue formation; but as the research work of injecting sclerosing substances into muscle was erroneous and as the test of subjection to time has again proved its general failure, its use must be limited to the application of very few.

It is not difficult to understand some of the older operative procedures as they were based on an incorrect concept of pathogenesis. Removal of the total outgrowth, including skin, testicle and hernial contents put the accent on thoroughness but invited a directly proportionate mortality rate. Later on, a purse-string operation, inverting the scrotal skin and hernial contents was less gargantuan but equally ineffective. The use of a button of bone removed from the symphysis to act as a plug at the deep ring was at least a step forward in the understanding of some of the principles involved. The first real progress was in the elimination of the sac which is still the *sine qua non* of success. On the other hand the utilization of the cremasteric muscle and fascia (Halsted) never had any logical or physiological basis. The suture of the internal oblique muscle to Poupart's ligament (Bassini) was an epoch-making step forward and resulted in a tremendous improvement in the operative results. But its error lay in the claim that the procedure built up the floor of the inguinal canal— a repair that is neither justifiable nor necessary, as there is no floor weakness in an indirect hernia, the lesion being entirely at the internal ring. Furthermore, muscle structure functions by contraction and relaxation, not by fixation which can result only in atrophy, weakness and ultimate paralysis with the resultant recurrence often larger than the primary hernia.

Why imbrication of the external oblique aponeurosis was and still is so frequently done, is rather difficult to understand. It becomes tense when the external oblique

muscle contracts and probably its main function, in addition to motion, is to protect the abdominal contents from external violence. It certainly does not prevent the emergence of viscera at either the deep or superficial ring. Imbrication merely fore-shortens the structure, a result that could be obtained by excising a portion and resuturing the edges.

Formerly great importance was ascribed to transplantation of the cord, particularly subaponeurotically, sometimes even subcutaneously. It seems to the author that the disposition of the cord in an indirect hernia makes very little difference, inasmuch as the size of the deep ring and the status of the internal oblique muscle are the dominating factors. On the other hand, in a direct hernia, transplantation is imperative, as building up the roof of the hernia (floor of the canal) is essential and this can best be done by close approximation of the internal oblique fascia and Poupart's ligament.

The claim of some that the type of suture material is the all important factor in the cure of hernia, is only partially true. The whole question of suture material has strangely gone through a complete cycle. From the non-absorbable silver wire as used fifty years ago we are back again to the use of alloy steel. In the interim catgut, linen, fascia, silk, cotton and lately plastic material, have been advocated and tried. It seems to the writer that the individual material is of less importance than the method of application, with accent on absence of tension, proper knotting, minimum trauma from handling, tying or clamping, complete hemostasis, general and vitamin status. The healing process is inherent in the tissues, the sutures merely contact them during the lag period. The finer the suture and the less the tissue reaction, the better prospect of primary union; and this is distinctly the modern trend. But whether chromic gut No. 00, fine silk, steel alloy are preferable, will ultimately be proved. The one big disadvantage of most non-absorbable

material is the occasional ensuing sinus, in case of infection, with months of discharge until extrusion or removal of the offending material. Infection will occur in any large series in every hospital at least in 2 to 3 per cent of the cases.

The first step if we are to improve the situation is to relegate the subject to the importance it deserves, especially owing to its common occurrence (5 per cent total population). It merits care, consideration and operation by the more mature members of the operative staff, and not as hitherto considered, by those of the house surgeon's realm. We must realize that the indirect and direct variety are two distinct entities and must, therefore, be treated differently. The introduction of some minor technical modification must be supplanted by a study, interpretation and application of physiologic-mechanical problems predicated upon increased anatomical knowledge.

The author's operations<sup>1,2</sup> for indirect and direct inguinal hernia are based on these factors. For the first type, elimination of the sac, narrowing of the lumen of the internal ring and placing the internal oblique muscle in a position so that its trap-door function can protect the internal ring. For the second type, the lower part of the transversalis fascia is reinforced, utilizing the internal oblique fascia, particularly at the pubic spine. Absence of tension is imperative in all types.

Recurrences with this type of operation are as follows:

*Primary:*

Indirect: 1.4 per cent  
82 hernioplastics, 71 follow-up,  
1 recurrence  
Direct: 11.7 per cent  
43 hernioplasties, 30 follow-up,  
4 recurrences  
Indirect-direct: 12.5 per cent  
11 hernioplasties, 8 follow up,  
1 recurrence

*Secondary:*

Indirect: .0 per cent  
Direct: 7.4 per cent  
17 hernioplasties, 14 follow-up  
1 recurrence

As each individual is subject to anatomic-physiologic variations, some beyond correction, even the proper application of the correct principle will not necessarily give 100 per cent results. However, if we can approach that goal by steady improvement, our efforts should be encouraged and continued.

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# ACUTE NONSPECIFIC MESENTERIC ADENITIS

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THIS disease has become a clinical entity during the past twenty years and has recently received considerable attention and study concerning etiology, physiology, pathology and attempt at diagnosis preoperatively. Even though exhaustive investigation has been done, considerable information is lacking, particularly as to cause and ability to diagnose the lesion definitely in order that surgery might be avoided in most instances. The purpose of this report is to continue to express the importance of the lesion and to point out how it is as yet impossible to diagnose the lesion definitely without laparotomy.

The lymph glands of the abdomen are divided into parietal and visceral groups. The visceral glands are associated with the branches of the celiac, superior and inferior mesenteric arteries. The superior mesenteric glands are divided into mesenteric, ileocolic and mesocolic groups. The mesenteric glands lie between the layers of the mesentery and vary between 100 and 150 in number.

The ileocolic glands, involved in mesenteric adenitis due to the close proximity of the appendix and ileum, number from ten to twenty and form a chain around the ileocolic artery and are grouped into ileal, anterior ileocolic and posterior ileocolic.

The lymphatic vessels of the ileum are termed lacteals and run between the layers of the mesentery and enter the mesenteric glands, the efferents of which end in the pre-aortic glands.

The lymphatic vessels of the appendix are numerous. From the body and tail of the vermiform process eight to five vessels ascend between the layers of the mesentery, one or two being interrupted in the

gland which lies between the layers of this peritoneal fold. They unite and end partly in the upper glands and partly in the lower glands of the ileocolic chain. Wilensky has stated that since the lymph drainage of the appendix is such only a congenital absence of such drainage will produce mesenteric adenitis from involvement of the appendix.

The nerve supply to the mesentery attached to the ileum is by means of the superior mesenteric plexus. This plexus also supplies the pancreas, other portions of the small intestine and the ascending and transverse colon. The appendix is supplied as is the small intestine by a secondary network of plexuses termed Auerbach's plexus and Meissner's plexus. It may be due to such nerve supply that pain referred from the ileum region, would account for varied areas of abdominal pain in mesenteric adenitis.

The clinical significance of acute mesenteric adenitis is of recent origin. Murphy made note of enlarged glands in 1908 but it was not until 1924 that Noesske urged inspection of the glands in abdominal pain of unknown origin.

From the eighty-four reported cases in this series thirty-five patients were not operated upon, leaving a surgical series of forty-nine cases. The thirty-five non-surgical patients recovered in one to five days. One patient was discharged in three days and returned in one week with a diagnosis of perforated appendix with abscess formation following which an appendectomy was done in two months, at which time the appendix was firmly bound down by adhesions.

The age in this series varied from three to sixty-five years of age; 18 per cent were

below ten years and 51 per cent were ten to twenty years of age; only 4 per cent were above thirty years. This age group coincides with Postlethwait's study of 771 cases and also coincides with Slaterry's and Hinton's survey on appendicitis, in which the second and third decades are most common periods.

No correlation as to season could be determined as the greatest months were January 12 per cent, August 20 per cent, September 13 per cent, and November 12 per cent, with October and December intervening with 3.5 and 4 per cent, respectively.

This study concurs with Tilley who reported sixty-nine cases and stated respiratory infection is inconstant. There was a history of preceding respiratory disease in 37 per cent of this series.

Sex incidence in this series was 38 per cent females and 62 per cent males in comparison with Postlethwait's collected series of 771 cases in which there were 44.6 per cent males and 55.4 per cent females. His own cases were 59 per cent males, which compares favorably to this study.

Fifty per cent had symptoms twenty-four hours or less and only 12 per cent had symptoms longer than seventy-two hours. In Slaterry and Hinton's review, the average duration for acute appendicitis was twenty-nine to thirty-nine hours and forty-eight to fifty-four hours for localized peritonitis following perforation. Twenty-five per cent of the appendicitis series had a history of previous attacks of abdominal pain as did this series of mesenteric adenitis.

The temperature was below 101°F. in 71.5 per cent of the cases and the appendicular series study had an average of 100.8°F., thus this factor is of no value in differentiation of the two lesions. 9.5 per cent had temperatures of 102° to 104°F. and Postlethwait reports 16 per cent with temperatures of 102° to 104°F.

Nausea and vomiting occurred in 73 per cent and 43 per cent had onset of pain in

the right lower quadrant. The pain was of severe character in 21 per cent and cramp-like in nature in 65 per cent. Tilley states that pain and soreness is prominent in mesenteric adenitis, while Slaterry and Hinton state that nausea and vomiting are more important than pain in appendicitis. Thirty-six per cent of Tilley's patients had onset of pain in the right lower quadrant which is usually against appendicitis. In this series 43 per cent had localized pain in the right lower quadrant, the other sites being general abdominal, umbilical, left lower quadrant and right upper quadrant.

Diarrhea and constipation are variable and not reliable symptoms.

In an appendicitis study 84 per cent had an average of 14,400 leucocyte count and 14.8 per cent had normal blood counts. This study revealed five counts of 20,000 or over, the highest being 24,600, and 30 per cent had 10,000 or less with an average leucocyte count of 11,700 with polymorphonuclears varying from 69 to 92 per cent. Postlethwait reports an average of 15,600 leucocytes. Thus it is not possible to differentiate mesenteric adenitis definitely from appendicular lesions by blood counts.

There were ten cases of acute appendicular obstructions in the series of eighty-four cases and one case of regional ileitis. Tilley reported eleven cases out of sixty-nine with appendicular lesions and stated most cases had injection of the terminal ileum and that free fluid in the peritoneal cavity was almost a routine finding, only six out of forty-four in Postlethwait's series had excess fluid and only three of this series were recorded.

The description of glands were hyperemic and grayish white varying in number from one and two to several; they also varied in size. It is estimated that any mesenteric gland larger than 0.5 cm. is diseased.

The postoperative course is not always asymptomatic as has been stated and distention and persistent abdominal pain are frequently present.

From available evidence it appears that the majority of cases are the result of the absorption from the lymphatic tissue of the ileum of bacteria, their toxins and other decomposition products. It has been suggested that spasm of the ileum is the most likely cause of pain rather than swelling and tightness of the peritoneal covering over the enlarged glands.

The following organisms have been cultured from excised glands: *Bacillus coli*, hemolytic streptococci, *Bacillus aerogenes*, and hemolytic staphylococcus. Positive cultures were obtained in only two out of forty-four cases in one series.

No deaths occurred in this series but fatalities have occurred from peritonitis secondary to suppurative mesenteric adenitis.

## CONCLUSION

Because the temperature, clinical course, signs, symptoms and blood studies of mesenteric adenitis resemble those of appendicular lesions and also because there is a possibility of suppurative glands perforating with resultant peritonitis, laparotomy should remain the procedure of choice to verify the diagnosis.

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# ASEPTIC RESECTION AND ANASTOMOSIS OF THE\* SMALL INTESTINE

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A METHOD of intestinal anastomosis developed in the experimental laboratory and previously reported has

bowel, the character of the mesenteric attachment and the histological components of the intestinal wall.

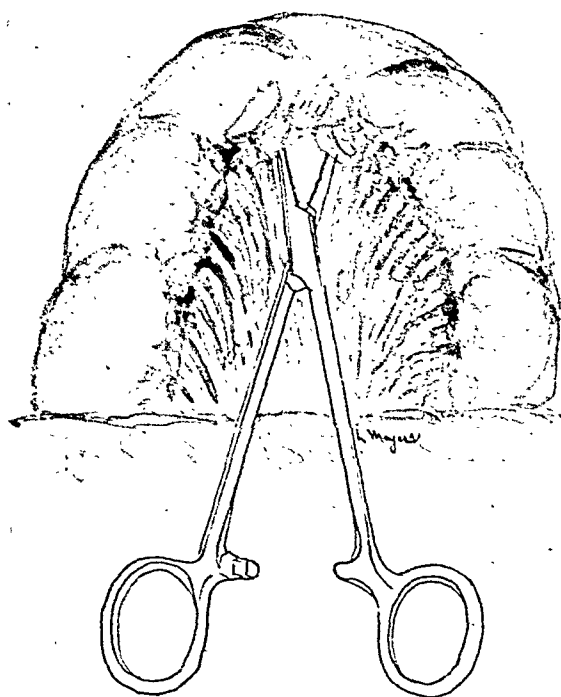


FIG. 1. This illustration shows the manner in which the mosquito forceps is pushed through the mesentery adjacent to the bowel at the level at which resection is to be done. Through this opening one arm of the Kocher forceps is inserted and the bowel is clamped.

been modified and employed in clinical cases with satisfactory results.

An effort has been made to reduce the technic to its ultimate simplicity while still maintaining the fundamental principles of intestinal surgery. The method was especially devised for the small intestine, taking into consideration the caliber of the

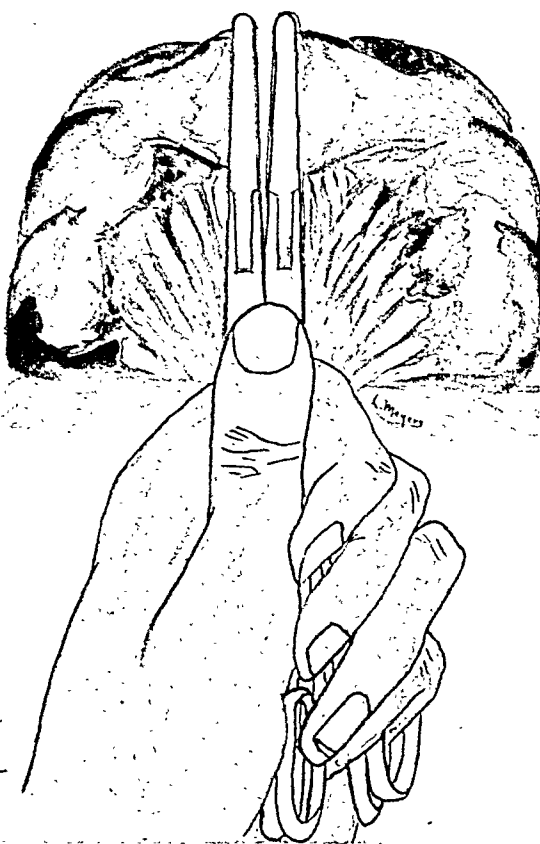


FIG. 2. Bowel ends are shown within grasp of Kocher forceps. The antimesenteric aspect of the bowel presents. The method by which the hand may hold the forceps satisfactorily stabilized is shown.

The technic to be described is considered advantageous for the following reasons: (1) It is relatively atraumatic; (2) it is relatively aseptic; (3) the procedure is safe as it permits accurate suturing, eliminates the "mesenteric angle," gives adequate serous apposition and is hemostatic.

*Armamentarium.* Kocher forceps serve quite satisfactorily as anastomotic clamps.

\* From the Department of Surgery, College of Medical Evangelists.

A straight two-inch Mayo intestinal needle, Halsted mosquito forceps, chromic catgut No. 0 on a straight swaged needle and

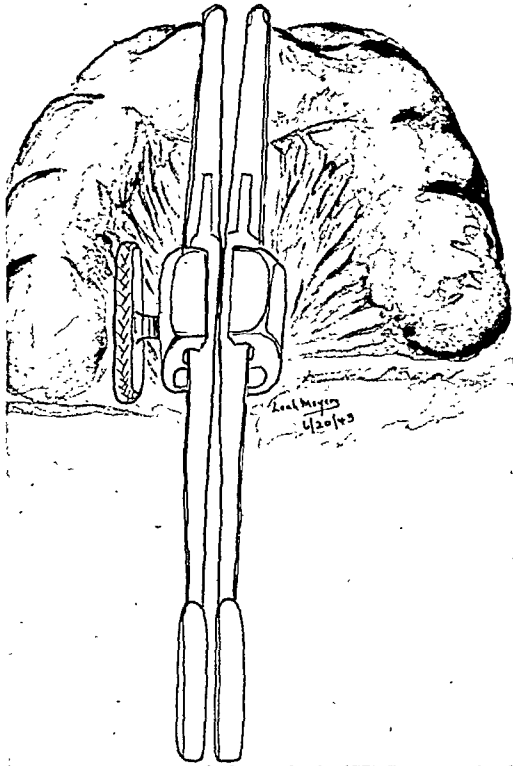


FIG. 3. Kocher forceps are shown within grasp of holding clamp which gives added stability.

Pagenstecher linen complete the list. A special holding clamp was devised to stabilize the forceps but when it is not available the forceps may be held in the hand in such a manner as to be quite stable.

**Procedure.** It is well to note that logical sequence in the successive steps of the procedure makes for simplicity. The point of a Halsted mosquito forceps is pushed through the mesentery adjacent to the bowel at the level at which the resection is to be done. The bowel is then crushed with a Kocher forceps by inserting one arm of the blade through the opening and clamping the bowel in such a manner that the mesenteric border is placed midway in the crushed area with the edges free of mesentery. The bowel is now cut through with cautery or knife. In the latter instance the application of phenol and alcohol is necessary.

The two forceps grasping the bowel ends to be anastomosed are placed side by side in the special holding clamp or hand, in such a manner as to stabilize the forceps and hold them in correct position for suturing. The forceps are then rotated through  $180^\circ$  vertical and turned through  $180^\circ$  horizontal in order to present the mesenteric borders up and the handles of the forceps toward the body of the operator.

The removal of the mesenteric attachment from the site of the future suture line is accomplished as follows: The mesentery of each bowel segment adjacent to the crushing forceps is clamped with a mosquito forceps, cut with a sharp knife from the grasp of the blades and pushed back far enough to enable placing sutures in the bowel wall completely free of mesenteric fat. The portion of mesentery caught by the mosquito forceps is ligated in order to insure hemostasis. This procedure is considered superior to the method of removal of the mesenteric attachment before application of the crushing forceps because the mesentery in the area to be denuded is held stabilized by the forceps and can be more accurately and completely removed from the bowel wall, and the necessary amount of bowel to be freed of mesentery can be accurately judged.

For suturing, a two-inch straight intestinal needle is preferred to the curved, as one may better gauge the depth of penetration, more certainly insure catching the submucosa and avoid entering the intestinal lumen.

The forceps are held in one hand and suturing performed with the other. The continuous suture of chromic catgut No. 0 is started at the far end of the bowel segment with the first insertion of the needle being taken in the direction of the long axis of the bowel. The remaining stitches except the last one are taken as a right angle Cushing suture. The last insertion of the needle is taken parallel with the long axis of the bowel and on the same bowel segment from which the suture was started. Beginning and ending the suture with

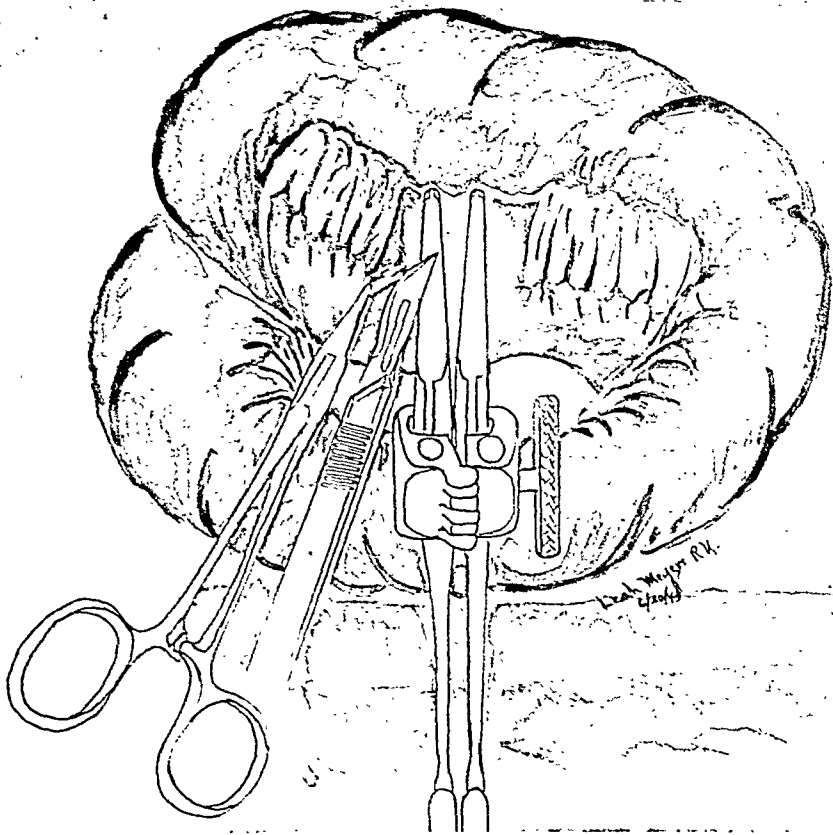


FIG. 4. The mesenteric aspect of the bowel presents after the forceps have been rotated through 180 degrees vertically and turned through 180 degrees horizontally. This view shows that the bowel has been clamped in such a manner that the mesenteric border is midway in the clamped area and well away from the bowel periphery adjacent to the forceps. The mesenteric attachment is shown stripped back for a distance sufficient to allow accurate insertion of sutures.

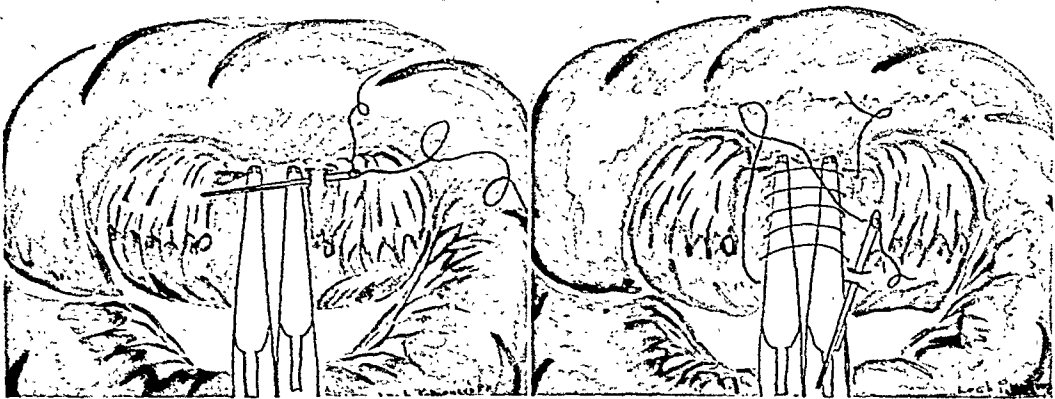


FIG. 5. This view shows the beginning of the right angle continuous suture on the mesenteric aspect with the first insertion of the needle being taken in the direction of the long axis of the bowel.

FIG. 6. This view shows continuation as a right angle suture with the stitches taken parallel with the forceps.

stitches parallel to the long axis of the bowel will make secure the angles at which the two continuous suture ends are tied be-

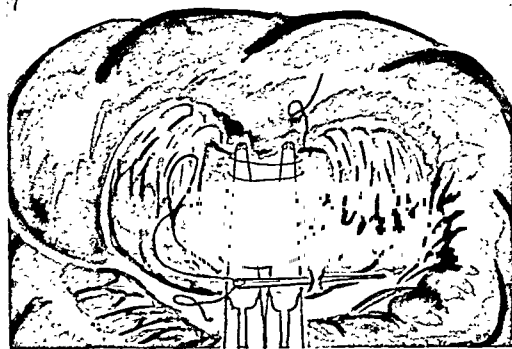


FIG. 7. This view shows the right angle continuous suture being completed on the mesenteric aspect of the bowel. Note that the last insertion of the needle is taken parallel with the long axis of the bowel and on the same bowel segment from which the suture was started.

cause there will be enough inversion of tissue to approximate serosa to serosa securely without undue encroachment on the lumen.

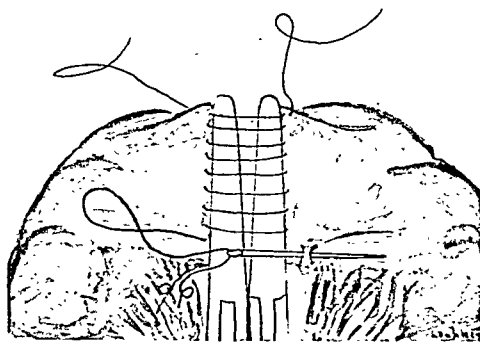


FIG. 8. Re-rotation and returning of the forceps has presented the antimesenteric aspect of the bowel in correct position for suturing. This view shows the suture completed. Note ends of sutures on opposite bowel segments.

Beginning and ending the suture on the same bowel segment allows for accurate approximation of the opposing bowel ends when the two sutures are drawn taut preliminary to tying.

After completion of the suture on the mesenteric aspect of the bowel, the forceps are rotated vertically and turned horizontally so that the opposite side of the

bowel, its antimesenteric aspect, presents and a similar suture is placed on this side with the stitch beginning and ending on the opposite bowel segment. As the bowel segments change position after rotation and turning, the suture is naturally started from the same relative position. After the forceps have been unlocked and removed the sutures are pulled taut, inverting the crushed bowel ends, and are tied tightly enough to cause slight inversion without constricting the lumen.

In completion of the anastomosis, the tied ends of the continuous right angle suture are buried with Halsted mattress sutures of Pagenstecher linen and reinforcing mattress sutures are placed around the entire periphery to complete the two layer anastomosis.

With only slight variation either side-to-side or end-to-side anastomosis may be performed as an aseptic procedure using essentially the same technic.

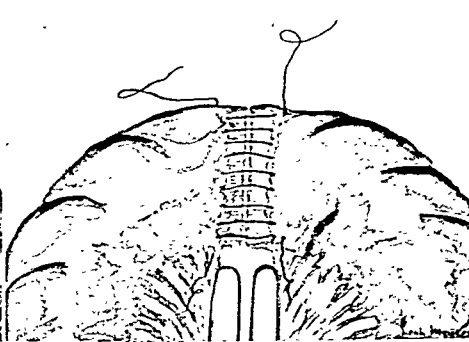


FIG. 9. Continuous sutures completed and forceps unlocked and withdrawn.

#### COMMENT

The manner of applying the forceps is considered important. It is difficult to place sutures accurately at the mesenteric angle when the usual method is employed, namely, that of applying the forceps so that the tips present at the mesenteric border.

When the forceps are applied so that the mesenteric border is midway in the crushed areas, it enables one to strip the mesentery back the required distance completely, so

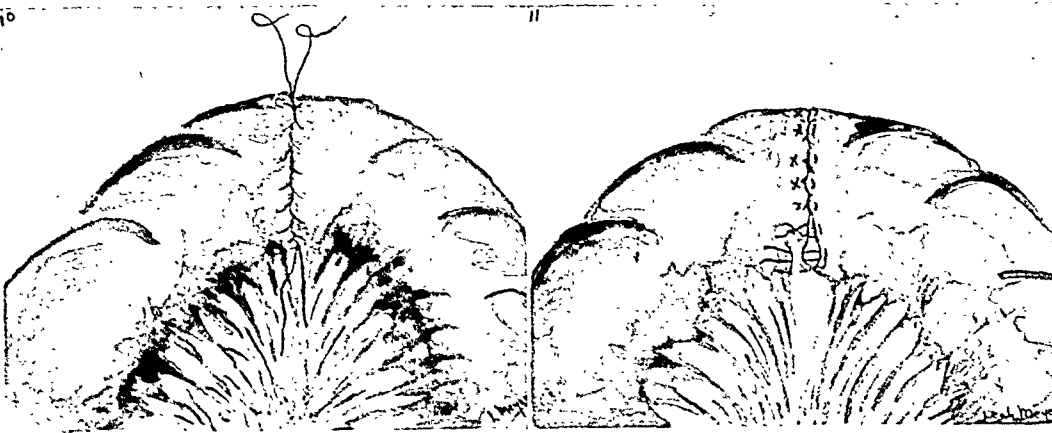


FIG. 10. Continuous sutures pulled taut and tied.

FIG. 11. Reinforcing interrupted mattress sutures placed around entire periphery.

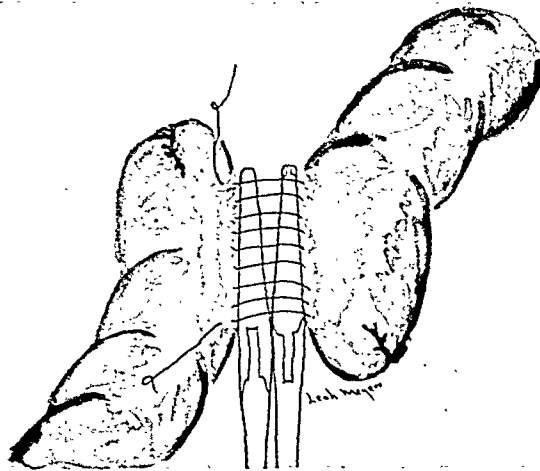


FIG. 12. This view shows method of placing continuous suture in side-to-side anastomosis. Note that suture begins and ends at right angles to the forceps and on the same bowel segment.

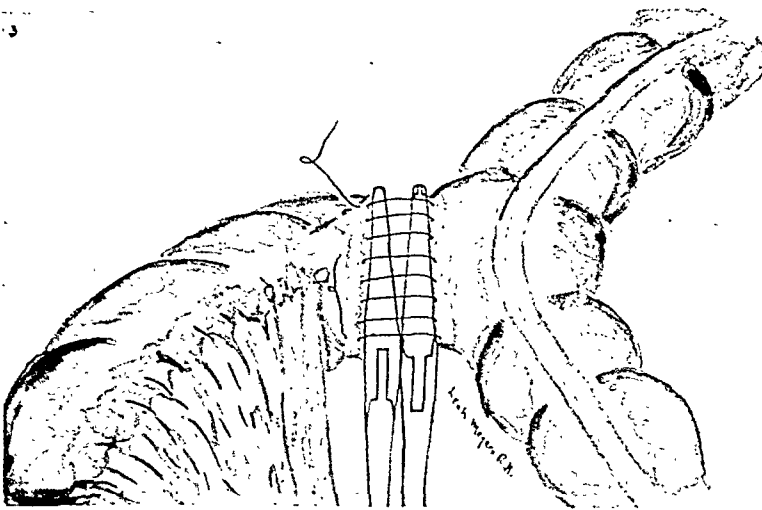


FIG. 13. This view shows method of placing continuous suture in end-to-side anastomosis. Note that suture begins and ends with stitches taken parallel with long axis of small bowel. The opposite suture should begin and end on the large bowel with the first and last stitch taken at right angles to the forceps.



that each suture may be accurately placed and eliminates entirely the "mesenteric angle" which in the ordinary type of anastomosis is the area most vulnerable to leak. This procedure likewise removes the point at which the two continuous suture ends are tied from the site of mesenteric attachment.

In a perusal of the recent literature on intestinal anastomosis, I have been impressed with the failure to stress a most important consideration which any satisfactory technic should include and the lack of which I believe is responsible for a definite percentage of fatal technical errors, namely, the necessity of including the submucosa within the bite of the needle in order to insure a suture that will give stability and holding power. It was Halsted who first called attention to this important fact.

In experimental work I have repeatedly been impressed with the sensation of "lack of resistance" which one obtains when only the serosa and muscularis are included in the stitch and conversely the "sense of security" when the submucosa is firmly caught.

It should be noted that if each stitch of the continuous suture is taken close to the well stabilized forceps, it will aid in accurate suturing as well as insure a minimum diaphragm of infolded tissue and still give adequate serous approximation.

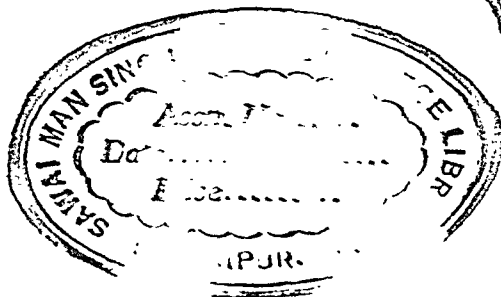
In all cases of strangulation obstruction

of comparatively short duration requiring resection, in which the bowel proximal to the strangulated loop has not suffered the changes incident to a long continued simple obstruction, as well as in the case of other pathological conditions which require resection, end-to-end aseptic anastomosis is the procedure of choice. Moderate edema of the proximal bowel segment is not a contraindication nor is moderate discrepancy in size of the two bowel ends.

Following obstruction of longer duration with pronounced edema of the proximal bowel and the presence of marked discrepancy in the size of the two bowel segments side-to-side anastomosis is indicated.

#### SUMMARY

A simplified technic of aseptic anastomosis is described which stresses fundamental principles in surgery of the small intestine. Special emphasis is given to the method of clamping the bowel in relation to the mesenteric border and the method of stripping the mesentery free from the proposed line of anastomosis. An important feature of the technic is elimination of the "mesenteric angle." The importance of including a portion of the submucosa with each stitch of the continuous suture is emphasized. The advantage of beginning and ending the continuous suture on the same bowel segment with stitches parallel to long axis of bowel is explained.



# PILONIDAL SINUS OR CYST—A MISNOMER

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WHAT appears to be the earliest appellation of that anatomical anomaly or developmental embryonic fault known as a pilonidal cyst or sinus, as such, and more recently referred to as a sacrococcygeal cyst or sinus was made by Warren in 1847. A detached analysis of both these terms from the perspective of embryology, pathology, anatomical location, present common designation and medical literature will influence many of us to consider these names both misleading and inadequate, and in particular the term, pilonidal, a misnomer.

Hubley R. Owen<sup>1</sup> referred in his paper on pilonidal sinuses to an oral communication on this subject that the author had made to him in 1934. At that time the writer stressed the need for a new and more descriptive term not based solely upon the anatomical location, but also from an embryological or germinal layer basis that would include both the cause and location. Also this appellation should make provision for the type of lesion and the degree of involvement in order that the stage of completeness or incompleteness and inflammatory change as it actually exists when treated or operated upon may be stated. Such a descriptive terminology might result in a more lucid and comprehensive compilation of statistics on this subject and insure a more logical and rational evaluation of the surgical treatment.

Persistence in the continued use of these terms and the present method of reporting operative statistics and postoperative results will continue to foster misleading surgical information. Also, the present generalized grouping of all the varying degrees of these pathologic entities permits no differentiation as to the character, degree or extent. This loose and all inclusive method will continue to contribute to

erroneous and controversial statistics and information concerning the end results of treatment until such time as a new, clearer and more explicit embryologic, anatomic and pathologic appellation is adopted.

The very term, pilonidal, derived as it is from conjoining the words "pilus," meaning hair, and "nidus," meaning a nest or a nest of hair (in a sinus or cyst), defeats by itself a proper description of itself. Personal observation over a period of years of many individuals with this condition, coupled with extensive reading and discussion of this subject with other physicians, has forced the conclusion that an attempt should be made to persuade the medical profession to adopt a more explanatory terminology. In the author's series of 132 cases, the anomaly in only four patients, slightly over 3 per cent, contained hair or a history of hair content was obtained. Other reported series have shown a much higher rate, and the greater proportion of reports have not even mentioned the presence or absence of hair. Compilation of several thousand case reports collected from various hospitals and literature averages less than 5 per cent but will vary decidedly in the same number of cases reported from other areas. The same situation unquestionably exists relative to the reported and unreported postoperative results.

Some difference of opinion exists about the etiologic theories concerning these pathologic occurrences. That these cysts and/or sinuses are epithelial lined is beyond question of reasonable doubt. That they are congenital also is beyond question. That they are always hair bearing and sacral or coccygeal in location is definitely questionable. Some authorities on pathology do not even deign to mention pilonidal or sacrococcygeal sinuses or cysts in their textbooks and with good

reason, in as much as they may be classified pathologically as dermoids of varying degrees.

Some authors have maintained that embryologically these tracts are the incompletely obliterated remains of varying degree of the lower portion of the neural canal. Others have apparently demonstrated that the cause is due to invagination and inclusion of the surface epithelium during the first three or four months of embryonic life, and in substantiation a connection has been shown through the sacrum with the neural canal causing meningeal irritation, inflammation and infection as cited by Walker and Bucy.<sup>2</sup> It is held forth that the tract is the result of improper separation of the neural tube from the neural groove. Stone,<sup>3</sup> in 1924, described the coccygeal fistula as such and also offered the very intriguing and ingenious suggestion that these tracts presented a structural analogy to the preen gland of birds. The preen gland is a definite avian component and its function well understood, but embryologically and pathologically the analogy cannot be substantiated. It is true that the preen gland is always situated in approximately the same relative anatomical location and so are the sacrococcygeal sinuses, cysts and dimples. However, similar structures are found also in other parts of the human economy far removed from this area where the pathologic picture is fundamentally the same as portrayed in the sacrococcygeal area.

The author does not consider that troublesome activation usually occurring between the ages of seventeen and twenty-five is indicative of glandular causation as has been suggested at various times. The fact that this age group usually embraces the years of utmost physical activity and irritation of the sacrococcygeal area may be more significant. Everyone familiar with the formation of the embryo needs but to recall the various infoldings and fusions of the early days of the fetus finally resulting in the formation of anterior and posterior raphes. How simple it is for a

small cell or rest of the epithelial layer to be included in, or pinched off by these infoldings and lie dormant until, under proper stimulation or irritation, it begins to grow and function in a foreign manner.

As mentioned before, reports have been presented from time to time of similar and identical pathological conditions occurring in other areas of the body, doubtless less frequently and less subject to irritation and constant trauma. P. A. McCarthy has verbally stated that he is aware of several of these occurring in the sternal region. The author has seen one case located in the region of the manubrium sterni in the female. This consisted of a tract about one inch deep, containing several small hairs, but it caused no trouble until about the age of thirty-two. At that time it became inflamed and started discharging.

Hagen<sup>4</sup> described one on the dorsum of the nose that included hair. This kind sometimes extends through the nasal bone in the anterior line. J. B. Ludy,<sup>5</sup> of Philadelphia, has shown some similar in structure, one in particular occurring in the midline of the lower lip, possibly due to improper fetal closure of the lateral halves of the mandible. This is not a common finding in cases of harelip and cleft palate, but it does occur. Some of these even discharge mucus.

No one can deny the presence of urachal cysts and sinuses presenting, at times, inflammation and discharge, and betraying faulty closures. Almost every urologist has seen perineal fistulas occurring anywhere from the tip of the penile opening to the anus and usually in the raphe itself. In fact, the burden of proof and occurrence places almost all these conditions in the raphe or fusion line, no matter in what part of the body they are located. These could readily and more descriptively be termed raphe (epithelial) inclusions. This term would serve to classify them immediately, whether or not hair is contained and regardless of anatomical location; but the latter could be added as a sacral or coccygeal or sternal raphe (epithelial) inclusion.

The tracts then could be further and more simply classified as within the following categories of developmental fusion according to degree as: (1) Complete, i.e., those that failed completely to close, resulting in a sinus; (2) partial, i.e., those that failed partly to close, resulting in a cyst or cysts with or without a sinus or sinuses; (3) incomplete, i.e., those that closed almost completely, resulting in a dimple or small recess. Pathologically any of these may or may not contain hair and may be further classified as: (1) asymptomatic, (2) symptomatic.

#### SUMMARY

1. The present appellation of pilonidal or sacro-coccygeal cyst or sinus is unsatisfactory.

2. The present statistical method of reporting end results of operative procedure is misleading.

3. The lack of a clearer classification leads to confusion and doubt. Under the

present system of general inclusiveness, one series of cases may present such extraordinary end results of operation that another group may attempt the same type of healing in an entirely different type of involvement with disastrous and discouraging results, and thus be influenced in discarding or destroying a perfect means of healing for another degree of disorder.

4. A clear appellation may serve to clarify the present dissension and subjugate the controversial issue between packing the extirpated area to heal from the bottom up or closing to heal by primary union, thus permitting a better estimation of operative end results.

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# RESTORATION OF FACIAL CONTOUR IN SURGERY OF THE SECONDARY CLEFT LIP AND PALATE\*

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THE importance of restoration of normal contours in facial deformities is now recognized not only by the surgeon, but by the psychologist as well. That facial disfigurement plays an important rôle in the production of psychoneurosis of various kinds has been proved in many instances. The adult may suffer both socially and economically to the point of complete mental derangement. Maladjustment, self-consciousness, frustration and depression are the usual sequelae of facial deformities. Acquired deformities more often create mental distress in adults than those which are congenital. Sometimes the victim of an accident is rendered temporarily unstable by the sudden shock of facing disfigurement for life. With the development of the machine age and the keen competition of individuals in their struggle for success, personal appearance plays too important a part in our daily program to be taken lightly.

In children, disfigurements attract the attention of all. Grown-ups are excited to pity, disgust or horror by deformed children. On the other hand, the child's playmates react in a different manner. Their curiosity is aroused and remarks passed publicly to ridicule or embarrass the victim are the rule rather than not. Children are unfortunately cruel to others less favored than themselves, little realizing what feeling of inferiority and depression they are creating in the minds of their playmates. This attitude is particularly manifest in congenital cleft lip and palate deformities, in which in addition to dis-

figurement, abnormalities in speech are present. The dread of ridicule and mocking during recitation in school is often enough to cower the most courageous little soul and mark him as a thing apart. Even though he may have mastered his lessons, his oral delivery and his appearance are obstacles too great to hurdle. As a result he becomes self-conscious, increasingly sensitive and maladjusted to his environment. As he grows older his mental attitude may so change that he becomes an economic and a social failure.

With these facts in mind, it becomes the duty of every surgeon who undertakes the correction of these deformities to see not only the immediate result, but the future development as well. A great surgeon once said aptly that there is no end to plastic surgery—another operation can always be done. This was in criticism of a series of operations advised by the author for the restoration of a more normal facial contour in the case of an old, badly operated hare-lip and cleft palate. The improvement after the series more than justified the undertaking and resulted in very advantageous economic and social advances.

The patients primarily selected for attention are those which have been operated upon in infancy or childhood and have an apparent disproportion in growth between the mandible and the maxillae. The maxillae are small, the mandible protrudes, the upper teeth are either crowded into the palate or partially lost through decay. The upper lip is scarred, flat and tightly bound down. It is usually out of all proportion to the lower lip. The accom-

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panying nasal deformity only increases the general irregularity of facial contour. The lip may be closed, the anterior part of the palate may be closed, but neither the lip nor the palate may be rated 25 per cent functional, and the individual may be miserably conscious of his deformities. Speech is badly impaired. Due to the disproportion in the maxilla-mandibular relationship, the lips are unable to meet in properly controlled labial, labiodental, linguodental and anterior linguopalatal sounds. Even the two consonant sounds of "m" and "n" which most cleft palate patients can pronounce intelligibly are difficult. The explosive labials "p," "b," "f," and "v" are almost impossibly rendered, while the "wh" and "w" are distorted into nasals. The anterior linguopalatals, "s," "z," "zh," "sh," etc., require an impediment in the breath column which cannot function with an abnormal palate, lip and jaw relationship. The problem thus becomes one, not only of restored contour but also one which involves function as well. The restoration of function will follow if proper contour is feasible. Speech training must follow the operative procedures. It must be remembered that these patients have developed a form of speech entirely at variance with the normal. The normal resonance and the natural melodious inflections of voice are entirely lost and defective substitutes of nasopharyngeal phonation is established.

Here then is a type of disfigurement which calls forth both vision and ingenuity if a result warranting the expenditure of effort and sacrifice is to be obtained. If the surgeon is planning a repair of this type would consider it from the standpoint of an old healed injury rather than accept it as a congenital deformity for which a great deal has been done, much of the reconstructive plan could be seen in an entirely different light. The face must be theoretically taken apart and analyzed from an artistic and esthetic viewpoint, and a plan evolved which will create a rehabilitated individual raised to the status

of a useful, happy being who can take his place as a normal citizen with the stigma of deformity removed. This may sound like a challenge, but much can be done if the problem is met intelligently.

In reviewing these cases certain characteristics are outstanding:

*The Lips.* Upon examination we find a narrow, tightly bound down upper lip, scarred from previous operations, meeting the lower at the angles only, and hindering any outward growth of the alveolar process. The lower lip protrudes beyond the apparent prognathus mandible to varying degrees. The central portion of the vermillion border can, under great effort, be controlled to meet the upper lip. It is usually loosely hung and has been singularly developed to take the active part in speech, the upper lip being more or less non-functioning. The teeth, when erupted, are forced into abnormal positions, become very irregular and many are lost early through decay or disease.

The first step in repair then centers itself in restoring the upper lip to as nearly a normal contour as possible. Four vital points must be considered: the size, the relation to the lower lip, restoration of the labial sulcus and the cupid's bow.

The size of the upper lip is determined by measuring the size of the lower. Allowance must be made for a certain amount of contracture and removal of scars. Several methods have been devised to increase the size of the lip. Upon careful analysis, we know that the original deformity occurs in the central portion of the lip and not at the angles. The repairs previously made have resulted in central scars. Therefore, the type of operation which utilizes the central portion of the lip has been chosen. This leaves the angles of the mouth unscarred and results in a more pleasing outline. The central portion may at the same time be lengthened which is also an advantage. In our hands, the Abbé operation, even though its disadvantages are well recognized, serves the best purposes. It is simple in design, restores full thickness

of the lip, including normal lining and covering, and brings a near normal relationship with the lower lip.

stumps are allowed to contract. Measurements are taken and a V-shaped flap is cut from the lower lip, leaving a small



FIG. 1. For descriptive legend see opposite page.

The operation consists of the transfer of a triangular pedicled flap from the lower lip to the upper lip. An incision extending from the base of the columella to and through the vermillion border is made in the center of the upper lip; the incision is carried through the entire substance of the lip creating a central defect. The lateral

pedicle at the vermillion border. The apex of the flap is turned and sutured to the apex of the triangular defect in the upper lip and all edges are carefully sutured in layers. The lower lip defect is closed in the same manner, and the two lips are sewed together with stay sutures. The patient is fed through a tube for a period

of fourteen days. At any time thereafter the flap may be excised from the pedicle, the vermillion borders of both lips re-

result. Unfortunately, mere closure of the cleft tissues leaves the soft palate pulled far forward and the oropharynx abnor-



FIG. 1. A and B, characteristic type of deformity; note tightly bound down upper lip, the apparent disproportion in growth between maxillae and mandible, the loosely hung lower lip, and irregularity of facial contour; C, the triangular transplant of full thickness of lower lip to upper prior to separation (Abbe operation); D and E, improved facial contour obtained by lip plastic and placement of denture.

arranged and the edges sutured. The stay sutures are removed and the patient allowed soft foods until healing occurs. In a comparatively short time marked improvement may be noted in both appearance and speech.

We now have a more nearly normal upper lip which meets the lower lip in the central portion as well as at the angles; and though it may be quite bound down to the alveolus in part, it is relatively equal in size and more mobile than before operation. The restoration of the labial sulcus and the creation of the cupid's bow is left until the palate is corrected.

*The Palate.* Depending upon the failure or successes from previous operations and the type of the original deformity, these cases may show any defect from a short, tense soft palate to a simple opening. In a large series of cases every type of secondary defect is encountered and good judgment is required if function is to be restored. There is a great tendency to consider a closed cleft in the palate as a good surgical

mally wide. The importance of obtaining velopharyngeal closure cannot be over-emphasized. The sphincter-like action between the oropharynx, nasopharynx and the posterior part of the tongue cannot exist in the presence of a short tense velum. Since a functioning palate depends upon length and flexibility, special study should be given these cases to procure, in addition to facial contour, the added palatal corrections. Variations in methods of correction are numerous, but any plan which will close existing openings and lengthen the palate with the least amount of scarring is recommended. Where feasible, the Dorrance push-back operation may be used advantageously.

*The Prosthesis.* In the construction of any prosthetic appliance for the correction of deformities of the maxilla or mandible, either congenital or acquired, the complete understanding by the surgeon of the existing prosthetic problems lends to the success of the construction and fabrication of the complicated appliances necessary.



In the case of oral deformities the biologic aspects must be the first consideration by the prosthodontist if he is to comparable to those made in a machine shop with the biologic aspect totally ignored. We are confronted with this



FIG. 2. For descriptive legend see opposite page.

be of any help to the surgeon. His knowledge and ingenuity in dental prostheses cannot be overbalanced or he would lose sight of the anatomy and physiology. The overemphasis of the mechanical side of dental prostheses all too often leads to the construction of appliances which would be

typical type picture: few remaining teeth, generally malposed or deformed and carious (in the majority of cases), and the whole presenting a badly impaired masticatory apparatus.

The prosthodontist must first realize the necessity of repairing the few remaining

teeth and have the mouth free from dental caries. These teeth then can be used as a guide for the prosthetic restoration. If

or approximately one-half hour per meal. This would leave a twenty-two and one-half hour rest period for the supporting tissues



FIG. 2. A and B, this patient has had the premaxillae excised, and an attempt made to close the lateral halves of the maxillae by crushing forceps—a surgical error. He was embarrassed and ridiculed by his schoolmates, because very maladjusted and self-conscious. C, large intra-oral skin graft placed to deepen labial and buccal sulci; D, denture with attachments to restore lost teeth and fill out irregularity of facial contours; E and F, result following the series of operations as outlined in the text. This patient now holds an important position and has become economically and socially independent. Compare with Fig. 2A and B.

possible, proper interdigitation of the remaining teeth should be established by the orthodontist so the teeth will have their proper occlusal antagonists. The absence of the premaxillae offers a most serious problem because the other teeth must be used as the non-resilient supports for the prosthetic appliance and its relation to the resilient supports. The problem is best handled by splinting the non-resilient supports together and having them act as a constant, combining the resilient with the non-resilient supports. With these factors under control it becomes possible to construct an appliance in a functioning unit. These appliances are built with the thought in mind of not subjecting them to more than one and one-half hours per day of masticating force

under the appliance. The longevity of these cases is dependent largely upon certain factors of which the most important problems are the degree of health and tone of the investing tissues of the teeth *in situ*.

*The Labial Sulcus.* In the majority of these cases, the upper lip, even when enlarged by the Abbé operation is still bound down to the external alveolar margin and is not flexible enough to allow full mobility. In order to obtain the proper external contour and the dental relationship, it is therefore necessary to deepen the labial (and sometimes the buccal) sulcus. With the denture in place, some estimate may be made of the amount of denture material needed to restore the contour and obtain a pleasing profile. The sulcus is deepened by incision of the mucosa beneath the lip,

using the normal buccal fold as the guide. The tissues are dissected from the bone and extended to a higher elevation than

modelling compound, heated to proper consistency, is added to the outer rim of the denture in sufficient amount to over-



A

B



C



D

FIG. 3. For descriptive legend see page 112.

will be eventually needed. This dissection creates a large pocket with raw areas on the sides of both the bone and the lip. When bleeding is controlled "Stent" or dental

fill the prepared raw pocket beneath the lip. The denture is now gradually forced to place with the lip fully extended by an assistant. The lip is then loosened and

allowed to droop over the denture while the surgeon moulds the overlying tissues and forces the compound well up into the pocket. A sharp impression, filling in the entire defect should be obtained, even though the compound may have to be reheated and replaced several times. When cooled, the denture is removed, the excess compound trimmed off, and by repeated trials a pleasing normal contour obtained.

attachments with trays for the compound for retention of the graft. Skin makes an excellent substitute for mucosa, and if



E



F



G



H

FIG. 3. For descriptive legend sss page 112.

The denture is now removed and set aside for the reception of the free skin graft.

Intra-oral skin grafts were first used by Esser during the first world war and named the Esser epithelial inlay. This method was improved by Gillies who used dental

kept extended for a period of time does not contract in the mouth. The donor area should be selected with care so that the skin used is thin and free from hair. The graft is cut in the usual manner, using either a special knife or the Padgett

dermatome if desired. The graft is draped over the modelling compound on the denture, so that when the denture is placed,

the prosthodontist for replacement of the compound rim. During this replacement the patient must wear some form of com-

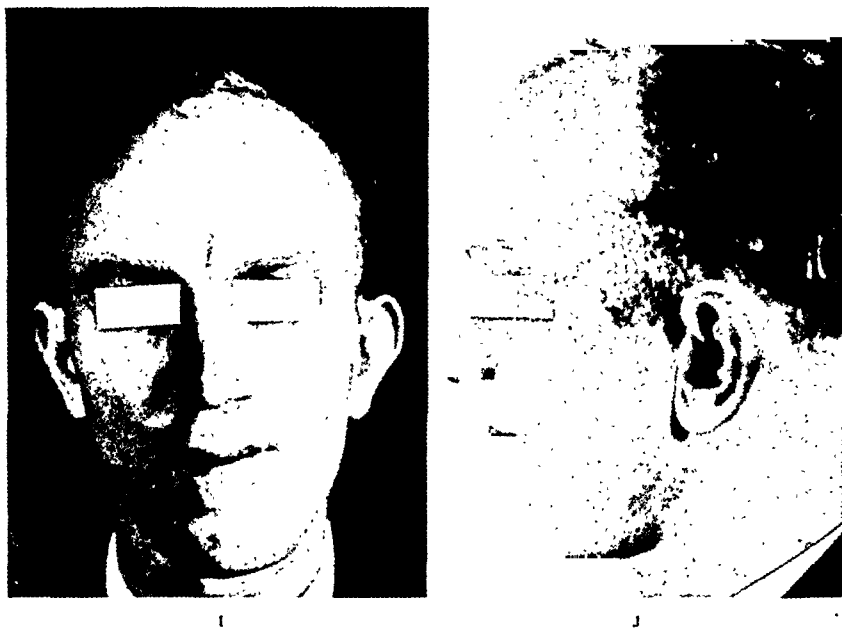


FIG. 3. A and B, the end result of a series of operations in infancy and childhood. Note the disproportion of maxillo-mandibular relationship, the inability to close the central portion of the lips, and the general irregularity in facial contour. C, immediate result following the Abbe operation with pedicle uncut; D, upper lip pulled upward and outward to show the deepened labial sulcus after extraction of malformed teeth and placement of intra-oral skin graft; E, dental prosthesis made to restore lost teeth and improve facial contour; F, the improvement in facial contour after rhinoplasty and placement of denture; G and H, comparable photographs showing changes in contour with lips separated; I and J, photographs—two years later—showing result of the series of operations listed in the text. Compare with Fig. 3A and B.

the raw surfaces of the graft and the raw surfaces of the pocket defect will be in contact. Excess graft may be excised, but there must be enough to cover all raw areas. The denture bearing the graft is fitted to place and the patient returned to bed. Instructions are given that the denture is not to be disturbed in any way for a period of ten to twelve days, liquids only being allowed as diet. At the end of this period, the denture is carefully removed, washed thoroughly, the excess graft trimmed away, and after cleansing the mouth, the denture is replaced. The graft must be kept in extension at all times for a period of several months or contracture and loss of space will result. The patient is instructed to wear the denture for two to four weeks before returning to

pound prosthesis to retain the grafted pocket in full expansion in order to prevent contracture. The replacement should be done within a twenty-four hour period if possible.

The artistic effect of the restored contour will be in direct proportion to the artistry displayed in the denture and the external surgical procedures. When the denture is replaced, the patient is dismissed for a few weeks with instruction for exercises of cheek, lips and tongue to restore muscle tone and facial expression. At this stage there is usually noted a beginning change in the patient's reactions. He is more self-confident, takes better care of his personal appearance and even though somewhat awkward in the use of his new denture, takes a new interest in life.

*The Nose.* The majority of these cases present some form of nasal deformity, varying from a large hump with a de-

contour has been obtained, it may be found that there are some slight irregularities in the vermillion border of the upper

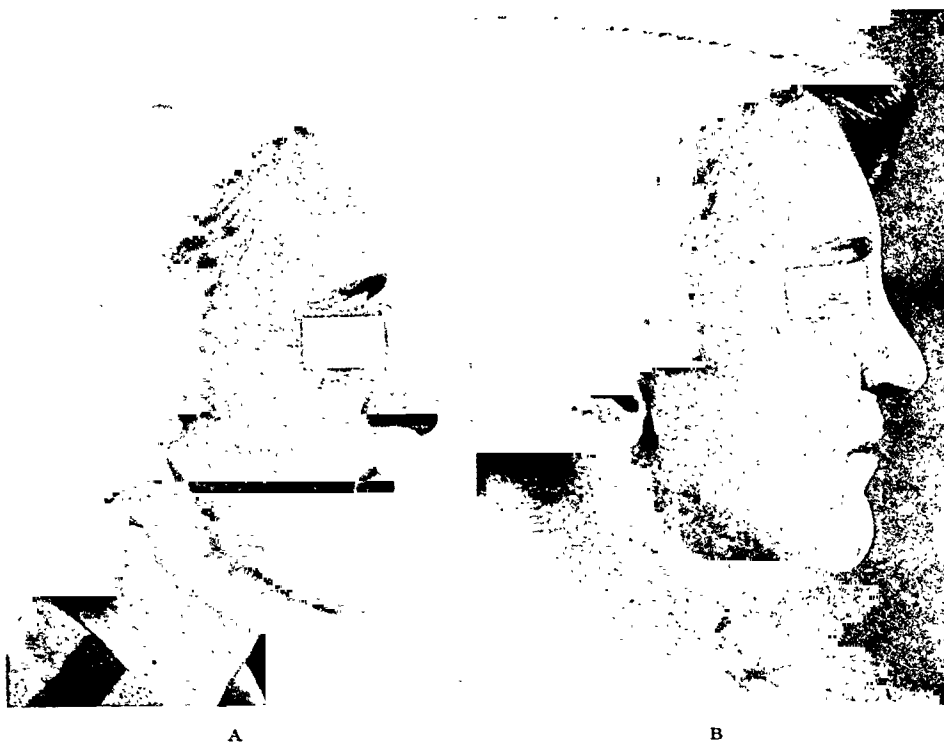


FIG. 4. A and B, A shows patient after several operative procedures in early infancy. The irregularity of facial contour is increased by the prognathus mandible and the long humped nose; B shows resulting improvement from rhinoplasty, intra-oral skin graft and prosthesis.

pressed tip to simple flattened ala. Nearly all have one nostril lying more horizontally than the other, and in many the lateral alar cartilage projects downward. The nose, being the most prominent facial feature, requires special study in relation to the face as a whole. An accurate diagnosis of the malformation should first be made. Where it is necessary, face masks may be taken and models made so that the correction may be readily planned. It would be difficult to undertake a detailed account of the operations designed to correct each deformity in a paper of this type. The field of rhinoplasty has been well covered by various authors and references to them are available to all. The surgical corrections should be carried out with the end in view to obtain as nearly normal a facial contour as possible.

*Cupid's Bow.* After all major deformities have been corrected and a pleasing

lip. These irregularities are most distressing to the patient. This presents a real problem to the female who uses lip stick which must be evenly applied. The formation of a Cupid's bow gives a much more pleasing outline and is not a difficult procedure. After the usual preparation, the Cupid's bow is outlined on the skin and mucosa with dye. Excision of the outline is made, the mucosa is undercut and raised to its new position and sutured with fine plastic sutures. The esthetic improvement is well worth the effort.

The follow-up on these patients is an interesting study. During the series of operations, it is noted that with each improvement the psychology of the individual changes. He no longer attempts to hide his deformity, he carries his head erect and loses that "beaten" look which has marked him for so long. He usually looks eagerly forward to the next operation and

becomes even critical of minor difficulties. Parents come to tell of demands for better clothes and more frequent hair-cuts, of the time spent in massaging scars and general personal improvement. If in school, his interest improves and he gets better grades. When the operations are finished and he becomes accustomed to the denture and the lip loses its tenseness and becomes flexible, he willingly spends time in facial exercises to improve his muscle tone and expression.

As time passes, there is a blending of the scarred tissues and most of these patients are able to take their places as normal useful citizens.

#### SUMMARY

1. Definite psychological problems exist in most cases of cleft palate and hare-lip with poor operative results.

2. A plea is made to consider these cases as old healed injuries with deformity rather than as a congenital deformity for which much has been done.

3. Typical cases are described and certain characteristics are outlined.

4. A definite plan for repair is made in a series of operations made step by step, each dependent upon the other for reasons given.

5. A more nearly normal facial contour, together with palatal correction may be made in the majority of these cases by careful planning.

#### CONCLUSIONS

1. An improved mental state follows correction of facial deformities due to poor results from early cleft lip and palate repair.

2. A definite step-by-step plan for correction is necessary if more nearly normal facial contour is to be obtained.

3. Social and economic improvement follow in the wake of improved facial contour and speech.

4. Close co-operation between surgeon and dentist is a necessity in these cases.

5. The deepened labial sulcus by intra-oral skin grafting allows the prosthodontist to obtain a properly fitted artistic denture to restore the contour of the face.

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# COMPRESSION FRACTURES OF THE LUMBAR VERTEBRA

## WITHOUT CORD INVOLVEMENT

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IN this modern day with the increasing activity of industry, the widespread use of automobiles and airplanes, and the popular enthusiasm for vigorous outdoor sports, by male and female, the number of spinal fractures has increased.

In the early days many cases were overlooked due possibly to inadequate facilities in making a diagnosis. Today, we are confronted with these same patients who exhibit pain and perhaps deformities which are determined only by a routine roentgenological examination to determine the etiological factor of their complaint. It is rather difficult to estimate how many such patients have become hopeless cripples. Many could have lived out life expectancy in a normal manner if only they had obtained adequate treatment at the time of injury.

This paper is limited to compression fractures of the lumbar region without cord involvement. Therefore, no mention is made of cervical spine injuries.

The anatomical location was as follows: dorsolumbar junction, thirty two; second lumbar, twenty two; third lumbar, six; fourth and fifth lumbar, three; total cases sixty three.

The type and location of compression fractures of the lumbar vertebra depend largely upon the nature of the trauma and whether the violence is applied to the vertebral column by direct or indirect force.

### FIRST AID

It is deplorable that many of the patients are treated by an overanxious individual who happens along, places the victim in an automobile and hurries him off to the hospital, without appreciating the damage which may be done by this form of transportation. Unfortunately, some of these

patients have dislocations added to the fracture. Credit must be given the Red Cross and other agencies for decreasing this type of handling through lay education. In no type of fracture of the entire skeletal system is properly administered first aid treatment as important as in fracture of the spine. The important dictum "splint them where they lie" which applies to all fractures, is of considerable consequence in these cases. Proper first aid treatment may save a life and often prevents the development of a hopeless cripple.

The treatment of spinal fractures should begin at the scene of the accident. Every ambulance attendant, policeman and even the general public should be taught the underlying principle in handling cases of back injury.

Rolling the patient into the prone position on a blanket and with meticulous care raising and placing him on a litter is the important first aid step in the treatment. Then careful transportation to the hospital for roentgenological study and adequate treatment should be instituted, keeping the patient still in the prone position.

### SIGNS AND SYMPTOMS

The signs and symptoms of a spinal injury may not be present immediately. We have perhaps all seen patients who have serious fractures, following an accident with minor complaints such as "pain or stiffness in the back," after which they have been able to get to their feet quickly and bend their body.

Certain signs and symptoms, if present, are pathognomonic of a fracture of the vertebrae though careful examination may be necessary to elicit them: (1) Localized pain over the site of fracture; (2) muscular rigidity of spinal muscles; (3) inability to stand erect; (4) weakness of back; (5)



retarded flexion at site of fracture, and (6) girdle pains may or may not be present.

#### DIAGNOSIS

With the roentgenologist primarily rests the burden of proof as to the presence and extent of fractures of the spine. Injuries with definite cord symptoms, while usually obvious clinically, still require a careful roentgenological examination just as do the patients presenting no definite clinical signs of fracture.

Since vertebral fractures are produced by hyperflexion when the limits of elasticity of the body is exceeded, a compression results. The spinal arch is composed of compact bone and as to the compressing force is exerted on the anterior portion of the body, the compression usually involves the anterior margin of the body. Compression or crushing fractures are most commonly encountered in the dorsolumbar region where flexion is least restricted while fractures from rotation and dislocations occur most frequently in the cervical region, the most flexible portion of the spine.

In routine radiography of spinal injuries anteroposterior and lateral views are always essential. Slight or moderately compressed bodies might easily be overlooked in the anteroposterior projection while a lateral film always demonstrates the reduced vertical height of the involved bodies quite strikingly. In this latter view the compressed bodies show a "wedging" or decreased height of the anterior portion of the body, the upper angle usually showing more compression than the lower angle. The resultant kyphos deformity depends upon the severity of the compression. Isolated fragments of the fractured body may be displaced forward slightly, limited by the anterior longitudinal ligament. Posterior displacement of isolated fragments into the spinal canal are also best demonstrated in the lateral projection.

Asymmetrical crushing of one or more bodies is not uncommon, resulting in a lateral deviation or scoliosis of the spine in addition to the kyphosis. These changes are

best shown in the anteroposterior view in which stereoscopic projections are frequently valuable.

In addition to the two views mentioned, right and left 45 degree oblique films may be invaluable in bringing out accompanying fractures of the articular processes in which case there may be a dislocation also. Oblique projections also may present further information regarding fractures of the posterior spinous process, pedicle or lamina, which fractures, however, are seen to best advantage in a properly exposed lateral film. The x-ray examination must always be executed with great care, moving the patient gently and as little as possible to prevent further cord damage.

Fractures of two, three, or four vertebral bodies by the one compressing injury is not uncommon, the uppermost body usually showing the greatest degree of deformity and the lowermost body the least compression.

#### TREATMENT

As recently as the late twenties the customary treatment for a compression fracture of the vertebrae was accomplished by placing the patient in a recumbent position on a Bradford frame with or without traction to the head or feet for a four months' period. Then molded shells of plaster were made anteriorly and posteriorly so that the patient could be turned at frequent intervals in order to prevent pressure sores, if they were not already present. This latter procedure was carried out over a period of two additional months and was followed by a plaster jacket which was applied for the next three months. One could hardly estimate the deaths that must have occurred during this lengthy treatment due to pneumonia, septicemia complication, local infections, etc.

Fortunately, such men as Davis, Rogers, Boehler, Dunlop, Magnuson, and others have given us a clear understanding of the existing pathological state present in these cases. They have stressed the importance of a thorough understanding of the anat-

omy involved and have formulated the treatment, which in my opinion, is the outstanding to date.

The type of treatment applied in this group following the method so adequately described by Davis which consists of hyperextension with forcible manipulation of the fracture and application of a plaster jacket. Reduction was accomplished as soon as possible; in over 50 per cent it was done immediately following the roentgenological examination.

When shock existed, opiates were administered in sufficient doses to alleviate pain. The patient was kept quiet and warm and placed on a flat bed until shock subsided. Reduction was done as soon as the condition of the patient warranted.

In numerous cases of this series, I gave opiates before reduction. This is not in strict accordance with Davis' method of treatment, but the use of a narcotic enabled me to lessen pain and muscle spasm, thus facilitating reduction.

The day following reduction, a check-up roentgenological study was done in each case.

Results were as follows: satisfactory reduction after first manipulation, fifty-three; unsatisfactory reduction after first manipulation, nine; unsatisfactory reduction after second manipulation, one. Only in one case was re-manipulation necessary a third time.

All patients were kept recumbent for a period of three to fourteen days after which they were allowed to be ambulatory. The cast was worn for four months and was followed by an adequate brace. Only occasionally did the cast have to be removed, for loss of weight, pressure sores, etc. Then a new jacket was always applied.

This method of treatment has greatly reduced the time required to return these individuals to their former occupation and has materially decreased the hospital stay which is, of course, an important factor from the economical standpoint.

After the jacket was removed, postural exercises were given with a warning against heavy lifting in a stooped position.

## PROGNOSIS

The majority of patients returned to their former occupations in five months. Those who had positions which did not require vigorous body activity and those who had less extensive fractures were returned sooner. Using methods similar to those described above, a patient who has had a compression fracture of the lumbar vertebra without cord involvement should get an excellent result. Most of the patients are able to carry on as well as before injury, unless their "damage suit" is still pending.

The treatment of sixty-three cases of compression fractures of the lumbar vertebra without cord involvement brings out the following points: (1) The danger of these cases being complicated through "Jack knifing by unskilled attendants is a formidable one." (2) "Place them prone and keep them prone" should be the watch word until the roentgenological study reveals the extent of the injury. (3) Reduction of fracture as soon as possible through manipulation while the spine is held in hyperextension and application of an adequate body cast have given us excellent results. (4) We have been impressed by the benefits of early ambulation and exercises.

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# ALLERGIC PHENOMENA IN RELATION TO ABDOMINAL WOUND EVISCERATION

## CASE REPORTS AND EXPERIMENTAL WORK\*

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**W**OUND separation with evisceration is one of the most serious complications encountered by the abdominal surgeon in his innumerable and varied laparotomies. Such a complication seldom, if ever, is anticipated at the time of operation; and because of this unpreparedness it becomes one of the most embarrassing and difficult conditions to explain to the patient, as well as to his relatives when the calamity occurs. In my opinion, wound dehiscence should never happen except where certain unpreventable systemic disease processes are present at the time of surgery.

Fortunately, evisceration does not occur often. Depending statistically upon the number of cases cited, it varies from approximately  $\frac{2}{10}$  to 2 or 3 per cent. When the surgeon is confronted with this dreaded complication, he should automatically consider the situation a critical emergency as important as the ruptured abdominal viscus or perforated tubal pregnancy, and, with no thought of conservative waiting, his treatment should be immediate and definite.

During the past year a very puzzling case study with certain individual peculiarities caused me to perform experimental allergic tests on the patient with suggestive results. This case study will be presented in detail in this paper along with a five-year survey of cases from the surgical service of the Good Samaritan Hospital in Los Angeles.

Naturally, delayed healing with evisceration occurs frequently in the carcinomatous, cachectic, luetic or debilitated patient with

some form of nutritional trophic disturbances, and defective suture material also may be a factor. Other indirect causes of evisceration should be considered under one heading, namely, any factor producing increased intra-abdominal pressure, such as excessive coughing, vomiting, or acute abdominal distention.

One should also consider the patient who takes an anesthetic poorly; in other words, that patient whose abdomen is never relaxed during the suturing process, which makes closure difficult.

The symptom picture of the patient who undergoes wound dehiscence is practically always that of a patient who is sick continuously from the date of surgery until the day of evisceration. These symptoms: fever, distention, nausea, fast pulse, etc., do not change to improvement as should be expected on the third postoperative day, but become progressively worse until there is noted some serum-staining of the dressing and often the sudden presence of wound gaping, revealing intestines on the abdominal surface.

Practically all wound separation occurs between the fifth and eleventh postoperative days. Although the operator may suspect that evisceration is going to occur, he hesitates to remove the clips until the routine sixth or seventh postoperative day, at which time the skin gapes open and the diagnosis is evident.

Treatment then should consist of immediate replacement of the viscera and strapping of the wound, and especially of the preferable method of resuturing the entire wound with non-absorbable material.

\* All cases reported are from surgical statistics of the Good Samaritan Hospital of Los Angeles within a five-year period.

It will be seen from the facts presented in the case report submitted that one cannot very well leave allergic reactions out of the question of evisceration etiology. The reader of this paper should constantly remember that the express purpose of the writer is to narrow the field of wound separation so as to consider only that individual patient with average wound-healing powers. It always has been an accepted fact that generalized cachexia—whether it be from malignancy, long standing chronic disease, old age, avitaminosis or marked anemia—practically always play an important rôle in the production of wound separation when this occurs under such circumstances. In a careful survey of the literature one finds that the majority of wound eviscerations occurred following surgery for malignancy. The chief factor which stimulated my interest in this subject definitely was not evisceration *per se*, but rather that individual wound separation which followed lower abdominal surgery in an apparently normal, healthy individual; furthermore, an individual who had healed quickly following major surgery just six months previously.

In favor of the theory that allergy plays an important part in the production of evisceration, the following case report is presented:

#### CASE REPORT

Mrs. J. K., age fifty-three, white, American, was operated upon for toxic goiter; no chromic catgut was used and convalescence was normal.

The patient was readmitted to the Good Samaritan Hospital April 9, 1939, suffering from a large fibroid uterus. Total hysterectomy was done April 10th, spinal and gas anesthetic being used. There was no operative reaction, but on third postoperative day she continued to run a slight fever and experienced persistent nausea and vomiting. The wound appeared good, but the patient did not improve although no definite cause could be found. On April 16th, the fifth postoperative day, the entire wound showed complete evisceration. No catgut sutures were in evidence except one

small strand of frayed and digested gut, and no knots were found. There was no trace of healing, but fascia and peritoneum were adhered. The wound was resutured with No. 5 and No. 3 Deknatel interrupted silk stitch. No drains were used.

This patient had a very stormy convalescence following secondary suture. She suffered all of the severe symptoms referable to acute gastric dilatation of the stomach as well as a very serious ileus. For three days following secondary repair she was treated with Wagensteen continuous suction, heat to the abdomen, intravenous fluids, enemas, and pitressin by hypodermic injection.

The wound, which had been sutured with interrupted No. 3 silk stitch closing peritoneum and fascia as one thick layer, healed completely and with no evidence of infection or weakness. In fact, the patient was able to go home one week after her radical evisceration. All stitches remained in for one week after she was home. The skin stitches were removed two weeks after surgery and it was at this time that allergic tests were performed on the patient.

These tests were made because of the shocking fact that five days after the operation none of the so-called "40-day" chromic gut remained in the fascial layer, not even the semblance of a knot in the extensive abdominal wound. We have here a striking example of a patient upon whom I had performed a thyroid operation just six months previously, but one in which no chromic catgut was used resulting in a quick convalescence, only to have the above stated wound rupture occur in the same patient for whom the only difference in technic was the use of chromic catgut in the second operation when none was used in the first. Thus, special tests on this chromic catgut were done.

From this case report it would appear that defective suture material could be ruled out. Had the chromic gut been defective in any part of its length, it would seem that at least a certain amount of suture material would have shown in the wound. In this case all gut was absorbed as if by magic. There was nothing in the reparative process of the wound that could

possibly be at fault, since six months previously I had performed a thyroidec-tomy on the same patient with rapid healing and a very satisfactory convalescence.

Based on a thorough analysis of the preceding case study along with experimental work to be discussed later, it is believed that certain patients are definitely allergic to certain types of absorbable catgut material, which fact would seem to play an important part in the mechanism of evisceration. This interesting case study caused me to make a radical and complete change in suture material in all types of surgery as well as to offer this paper.

In discussing this subject with other surgeons I find that those operators who use non-absorbable suture material throughout the entire abdominal wall have experienced no evidence of evisceration, either partial or complete.

Among writers discussing postoperative dehiscence, Hinton<sup>1</sup> has shown that chromic catgut was completely absorbed in his "clean cases" in which the bacterial cultures were negative. However, he believed that infection, when present, did play an important part in evisceration. It is my belief that in all "clean" operations neither infection nor hematoma formation plays any part in the mechanism of wound dehiscence.

In an account of fifty cases studied by Meleney and Howes,<sup>2</sup> they state that in all of their cases, whether occurring on the third or thirteenth day, the operator reported complete digestion of chromic gut, a fact which was true where there was absolutely no evidence of infection.

According to Kraissl<sup>3</sup> and co-workers, all of their animals experimentally sensitized with chromic gut enclosure, disrupted on the third to sixth postoperative day. All five of their patients who disrupted their abdominal wounds and who had histories of allergy, showed evidence of sensitivity to chromic gut.

It is the belief of Babcock<sup>4</sup> that allergic reactions are produced in the tissues which retard healing. He points out that there

is much less reaction around silk than around catgut sutures.

Hinton, Kraissl, and Babcock all advance the theory that sensitivity to catgut may be responsible for premature absorption.

#### WOUND DEHISCENCE

Wound separation may be either partial or complete. A partial separation may be described as that condition in which the peritoneum and the fascia have begun to separate enough to allow the omentum or a knuckle of bowel to protrude a little into the opening, thus producing the partial evisceration. Such a condition, if obstruction does not supervene, can be compared with the postoperative ventral hernia in that the mechanisms are very similar. With each respiration, straining, coughing, vomiting, etc., there is a forward surge of bowel and omentum bombarding against the ventral postoperative herniation, tending to increase the fresh partial evisceration. In either case, there is a definite defect in both peritoneum and fascia with adhesions of omentum to muscle.

Wound separation may be partial as to its length as well as to its depth. Such wound separation may be partial in part of the wound and complete in another part; also, the separation may be complete throughout the entire extent of the wound, or there may be only a partial separation but extending throughout its full length.

Complete evisceration is that condition in which there is a separation of the abdominal surgical wound through its entire length, allowing omentum and bowel to eviscerate onto the abdomen.

Anatomically, the mechanism of wound separation may be classified as to the important layers of the abdominal wall that are involved in the separation: (1) The heavy anterior fascial sheath; (2) the thin weak posterior fascial sheath, and (3) the peritoneum and skin.

The mechanism of wound separation may be divided into upper abdominal

and lower abdominal. Anatomy and physiology play different rôles in their respective effects in the lower abdomen from

in postoperative ventral hernia, whereas in the lower abdomen evisceration results. It is believed that the etiology of ventral



FIG. 1.

FIG. 1. A photograph cross section of No. 2 forty-day chromic catgut sectioned in paraffin block. This shows the normal diameter and contour of chromic catgut in cross section. The lower edge of this chromic gut was slightly frayed in the process of cutting the paraffin block. It was found extremely difficult to section different types of suture material. It is also noted that with this gut there is one solid unit of material present which, when it is fragmented or digested, would naturally completely weaken itself. The opposite is true when silk is used since there are innumerable individual strands as shown in Figure 2.



FIG. 2.

FIG. 2. This photograph is a cross section of No. 3 Deknatel silk sectioned in paraffin block. It shows the innumerable individual silk fibers present in a cross section of one strand of No. 3 Deknatel silk. Each individual fragment is a fiber in the silk. All of these fibers braided together produce an unusually strong suture material which is practically as strong as silver wire in its tensile strength since silver wire is weakened in the twisting of it. No. 4 Deknatel silk has the same type of cross section except there are more individual fibers. This stitch is unbreakable in a steady pull, and I believe it is stronger than either silver wire or kangaroo tendon. I am using this type of suture material now for bone repair work and find it extremely satisfactory in that this silk has absolutely no capillary attraction and gives no reaction of any kind when left buried in either bone or soft tissue. At the same time it offers a suture material of extremely high tensile strength and one which will hold the fragments of bone in adequate apposition in healing. It is better than either gut or wire.

those in the upper abdomen. In wound separation involving the upper abdomen, the omentum, provided there is no bowel obstruction, may commonly act as a bulwark of defense, and by its adhesion to the muscle prevent the partial separation from becoming complete. If one were to consider only physiological reasons, one would feel that wound separation in the upper abdomen more commonly results

hernia depends largely upon the continuous bombardment of the adhered omentum against the anterior abdomen with each downward-forward surge of each respiration. Ventral hernia is common in the upper abdomen, and it would seem logical to assume that it is this plugging of the defect with adhered omentum which maintains the condition in the upper abdomen one of ventral hernia rather

than one of complete evisceration. In this survey of a private hospital it would seem to indicate that the omentum does



FIG. 3. This photograph shows very clearly the extreme fragmentation and digestion of one frayed, minute fragment of chromic catgut, found at one end of fascial plane in the eviscerated abdomen. This strand of material was extremely frayed and necrotic. There was no evidence anywhere of chromic catgut knots even though the catgut had been tied four different times at one place. The cross section of this frayed chromic gut shows the marked amount of fragmentation and separation into innumerable different fragments. This fragmented gut showed every evidence that it would be digested in that it was softened, macerated and necrotic. The fact that no stitches were left *in situ* in the fascia, and no chromic gut knots were found in the fascia, seemed striking evidence that we were dealing with some unknown allergic phenomenon or unknown chemical agent present in this particular body which seemed rapidly to eat up the chromic gut before healing could occur.

play a certain part since practically all cases of complete evisceration involved only the lower abdomen. If the wound separation is so severe as to produce complete evisceration in the upper abdomen, the prognosis becomes much more serious than the same condition in the lower abdomen.

The attending surgeon cannot afford

to have such a drastic accident occur in his normally convalescing operative patient, as there is a definite ill effect psychologically not only upon the patient but upon the relatives and friends of the patient who know of such an occurrence. Unfortunately, the layman never understands why he had to have his "stomach" opened twice in one week. It is my opinion that evisceration constitutes a definite hazard in surgical practice.

It is believed that if the alert, attending physician diagnoses an early partial or even complete evisceration, provided it is discovered within the first twelve hours before there is any adhesion between the bowel and abdominal wall, he may cure the evisceration by simply replacing the visceral contents into the abdomen. Every sterile precaution of course should be used during the process, a hypodermic administered to the patient whose position in bed should remain unchanged, and the field of the wound cleansed with tincture of metaphen or a similar antiseptic.

When all the exposed contents are completely within the abdomen, the surgeon brings the edges of the wound out in apposition, holding it in place while a nurse paints the abdominal wall with tincture of benzoin well down on the sides of the patient. The wound is then strapped tightly together with two-inch adhesive tape, each strip being overlapped and criss-crossed obliquely over the abdomen.

I shall not readily forget my personal, rather dramatic experience of performing the preceding operation. We naturally were quite worried about a patient who did not respond well after surgery, in whom there was a persistent fever, slightly rapid pulse, and especially persistent nausea with emesis. It had always been a rule adopted by Dr. Charles T. Sturgeon, with whom I was working, to do frequent dressings on this type of case, looking for, first, evidence of wound infection; second, any postoperative wound serum, and third, any evidence of wound separation.

I saw this particular patient at nine in the evening and, because of her complaints regarding gas distention and nausea associated at this time with a sudden rise in temperature, I immediately ordered a dressing tray and examined the surgical wound. On lifting the sterile dressings, approximately two feet of small bowel were visible on top of the abdomen. This being a very fresh state of evisceration, I put on sterile gloves, cleansed the wound edges, placed the bowels in the abdomen, and closed the wound with two-inch tape, applying tincture of benzoin. Due to the fact that this patient had a known weakness in her lungs, my surgical judgment decided me to treat her conservatively by strapping rather than subjecting her to prolonged anesthesia and surgical resuture. Firm union of the outer abdominal wall resulted without secondary stitches. The patient improved rapidly without further complications, with the exception that she developed a late postoperative ventral hernia.

Probably such an unhappy situation has confronted the majority of surgeons. Since this experience about seven years ago, I have had three similar misfortunes, but on all of them secondary repair was performed with satisfactory results. Two of these patients were operated upon at a private hospital while a third patient was operated upon at the County Hospital, which I shall not present in this series. In this report only a private hospital survey is being made.

#### FIVE-YEAR HOSPITAL SURVEY OF CASES

CASE I. Mrs. D. B., white, age fifty, was admitted to the hospital on October 15, 1934. Hysterectomy was performed on October 16th. The abdomen was repaired with plain No. 1 doubled for peritoneum, and 40-day No. 2 chromic in the fascia. Complete evisceration occurred on October 21st. This patient I treated by carefully releasing fresh adhesions of small bowel from the skin edges after which the intestines were placed within the abdomen and the wound strapped thoroughly with criss-cross formation. Normal convalescence

followed and the patient was discharged from the hospital on November 22nd.

CASE II. Mrs. E. B., white, age forty-seven, was admitted to the hospital December 1, 1936. Hysterectomy was performed December 2nd. Repair was done with plain No. 1 catgut doubled for peritoneum, and 40-day No. 2 for fascia. Complete evisceration occurred December 8th. The wound was resutured with through-and-through dermal sutures. Normal convalescence followed and the patient was discharged from the hospital on December 23rd.

CASE III. Mrs. C. W., white, age sixty-four, was admitted to the hospital November 11, 1936. Hysterectomy was performed November 12th, and the abdomen was closed with plain No. 1 catgut for peritoneum and 40-day Number 2 chromic for fascia. Complete evisceration occurred on November 21st. The wound was resutured with through-and-through dermal stitch and normal convalescence followed. She was discharged from the hospital on December 12th.

CASE IV. Mrs. J. M., white, age twenty-three, was admitted to the hospital December 14, 1936. Suspension of the uterus was performed on December 16th. Abdominal closure was done with plain No. 1 and chromic gut. Complete evisceration of the entire length of wound occurred on December 22nd. There was no evidence of infection and no evidence of healing. The wound was resutured with through-and-through dermal stitch. Normal convalescence followed and she was discharged from the hospital January 3, 1937.

CASE V. Mr. R. S., white, age fifty-three, was admitted to the hospital January 26, 1935. Cholecystectomy was performed on January 29th and the abdomen closed with plain No. 1 gut and No. 2 chromic. Complete evisceration occurred February 11th. The wound was resutured with through-and-through dermal stitch. The patient died on February 17th.

CASE VI. Mrs. J. A., white, age sixty-one, was admitted to the hospital March 15, 1937. Hysterectomy was done by myself March 16th and closure performed with plain No. 1 and chromic catgut. Complete evisceration occurred on March 25th. The wound was resutured with figure-of-eight and interrupted chromic catgut and reinforced with through-and-through silkworm gut sutures. Normal convalescence followed but later a postopera-



tive hernia developed. The patient was discharged from the hospital April 12, 1937.

CASE VII. Mrs. C. L., white, age thirty-five, was admitted to the hospital June 6, 1938. Hysterectomy was done on June 7. Closure was performed with plain No. 1 and chromic catgut. All catgut was found completely absorbed at the time of evisceration on June 16th. The wound was resutured with through-and-through dermal stitch. Normal convalescence followed and the patient was discharged on June 27th.

CASE VIII. Mrs. L. P., white, age fifty-one, was admitted to the hospital October 14, 1938. Hysterectomy was done October 15th. Closure was made with plain No. 1 and chromic catgut. Partial evisceration occurred on October 25th. The wound was resutured with figure-of-eight and interrupted chromic gut, also silkworm gut. Normal convalescence followed and she was discharged November 15th.

CASE IX. Mrs. G. W., white, age thirty, was admitted to the hospital June 17, 1938. She was operated upon June 18th for carcinoma of the rectum. Closure was made with plain No. 1 and chromic catgut. Complete evisceration occurred on June 23rd. The wound was resutured with through-and-through dermal stitch but the patient died on June 25th.

CASE X. Miss E. B., white, age forty-two, was admitted to the hospital October 13, 1938, for multicystic ovarian cyst. Closure was performed with plain No. 1 catgut and interrupted chromic catgut in fascia. Complete evisceration of the entire wound occurred on October 26th. The abdomen was resutured with silver wire suture material. Normal convalescence followed and she was discharged November 17th.

CASE XI. Mrs. J. K., white, age fifty-three, was admitted to the hospital April 9, 1939. Total hysterectomy was performed by myself on April 10th and closure made with plain No. 1 gut for peritoneum, 40-day catgut for fascia. Complete evisceration of the entire wound occurred on April 16th with no healing, no infection, nor evidence of 40-day chromic catgut left in wound. The wound was resutured with figure-of-eight and interrupted Deknatel No. 3 and No. 5 silk stitch. Normal convalescence followed and the patient was discharged from the hospital April 24th.

An additional very interesting case report was called to my attention by Dr. C. J. Berne when he found that I was working on this subject. The following case is given:

CASE XII. Mr. D. G., age thirty-nine, white, was admitted to the Good Samaritan Hospital on February 18th. An abdominal operation was performed on February 19th. The abdomen was repaired with plain and chromic catgut, also three dermal retention sutures. The patient seemed to develop post-operative ileus, and on February 23rd was operated upon. Operative findings disclosed: entire and complete wound evisceration with loop of bowel up through the wound under the skin surface. Only a slight two-inch strand of plain catgut was found over the peritoneum at one edge. Not one minute particle of chromic gut, not even a knot, was found although it was only the fourth postoperative day.

The patient was resutured with braided silk No. 5 interrupted suture material. Following further treatment for ileus, the patient had an uneventful convalescence. During a personal conversation with Doctor Berne regarding this case, he was very emphatic in stating that the wound was entirely free of chromic suture and it seemed that some agent had completely absorbed the suture material. This case is almost identical in its characteristics with my Case XI.

Medical men accept the fact that individuals react differently to various drugs and foods and that they may be allergic to certain drugs, foods, etc. With these facts in mind, is it not reasonable to suggest that a specific individual may be sensitive or allergic to the chromic catgut used in suturing a wound? This surely would explain the unusual catalytic type of digestion and absorption of the chromic catgut.

Surely there is some unknown chemistry that goes on in this particular abdomen in the process of wound healing in that the catgut is so quickly destroyed, long before firm healing has occurred. However, it must be remembered that in the patient with normal nutritional background, this type of chemistry does not prevent satisfactory wound healing following the use of secondary suture with non-absorbable material.

## ALLERGIC MANIFESTATIONS

In retrospect, when the surgeon carefully reviews the immediate postoperative course of his patients with evisceration, he will usually observe that the patient was ailing continuously from the time of operation until the day of actual observed evisceration, which usually is the day that he removes the clips or skin stitches. That case does not seem to respond well following surgery. His chart indicates a continual low-grade temperature, nausea that develops into emesis, distention, gas pains, poor color, elevated pulse and, when ileus becomes more apparent, a coffee-ground foul emesis which frequently is projectile in character. Theoretically, it would appear that wound separation actually begins immediately after the patient leaves the operating room; that there is some chemical produced in the wound, possibly some allergenic substance, which acts immediately to poison the patient and at the same time to dissolve the catgut more rapidly than normally. It would seem that possibly this same poisonous allergenic substance acts to prevent average normal healing of the wound.

Catgut is derived from an animal (the sheep) whose serum is especially prone to cause allergic reactions in humans, thus the problem that possibly allergic reactions to the suture material may be due to its derivation. Possibly the reaction of the abdominal tissue to the catgut produces liquefaction which greatly delays the process of healing, even to the point of wound separation. There is decidedly much less tissue reaction around silk suture, cotton suture, or wire.

Although it is believed that the evisceration *per se* is an abrupt sudden rending apart of the abdominal wound, at the same time it is believed that in such a case there is a gradual chemical reaction, either allergic or otherwise, going on in this patient's wound immediately after the operation and progressively becoming worse until the evisceration occurs. It is believed

that this progressive wound chemical action is a part of the reason for the patient's being "sick" continuously after the surgery up until the evisceration occurs. All of these patients are more or less distended after surgery and remain so until evisceration. The question is, why is it that one patient may be just as distended following a bowel obstruction and have the same suture material used but never suffer with evisceration? Every surgeon has experienced the case of a patient who has developed pneumonia following surgery, the patient who has had persistent coughing and gastric dilatation with persistent vomiting, but no evisceration. In view of these facts, one cannot consider that evisceration is solely due to an increased intra-abdominal tension. One cannot help but wonder whether in that particular case there is some unknown wound chemistry or allergy to the suture material used, or, more probably, actual defective suture material in combination with increased chemical action upon it to bring about the evisceration.

It is my contention that in all the cases of the normal convalescent, evisceration is not due to the operator's technic, nor to any one of numerous conditions causing the wound separation, but rather it is due to the suture material used in repair of the abdominal wall and, theoretically, possibly a chemical agent in that particular patient's body which acts quickly to dissolve the gut material. The patient has a definite idiosyncrasy to the chromicized gut and, as in all allergic conditions, attempts to throw off this poisonous material. Since the patient cannot throw it off by vomiting or similar methods, the next best thing is done—the so-called 40-day gut is digested in very quick fashion. Thus, within five days after operation not one minute strand or knot of chromic gut is left in the wound.

Along with this theoretical argument in favor of allergic wound evisceration, one must also consider briefly defective suture material. I believe, however, that such a condition is indeed rare fortunately, and

I say this because if the suture material were defective there would still undoubtedly be certain shreds or frayed-out portions of the suture left in the wound. At least the knots would still be present. The very fact that the wound is practically swept clean of all suture material is evidence against the suture being defective, and at the same time is evidence for the argument of catalytic wound digestion and absorption of catgut.

One cannot overlook the fact that there is a great variability in the rate of absorption of suture material in different individuals. Also it would seem that there is variability in the absorption time of different makes of catgut, and even there may be variations within the same grade of suture.

#### TREATMENT

There are two methods of treatment: (1) the conservative method to be used at the bedside, consisting of thorough strapping of the wound together, being very careful to use sterile technic throughout; (2) resuture of the wound with interrupted non-absorbable sutures, these sutures being through-and-through the adhered peritoneum and fascia and some through-and-through the entire abdominal wall. Both methods of treatment should be performed only after great care is used first to replace the intestines within the peritoneal cavity and to be sure there are no adhered intestines or omentum protruding out into the suture line. The surgical risk should be studied in each case and the conservative method practiced only when one is dealing with a critically ill patient or possibly the patient who is just beginning to eviscerate partially. Usually the secondary repair with non-absorbable suture is the method of choice and end results usually are satisfactory.

Naturally, in both methods it is very important to treat the patient's general condition symptomatically, as for example: (1) Treatment of acute dilatation and ileus by immediate and continuous suction-

decompression; (2) the use of pitressin or other similar smooth muscle stimulants along with the usual enemas; (3) plenty of intravenous glucose and salt solution to combat shock and dehydration; (4) the routine postoperative use of carbon dioxide inhalation three times daily for thorough lung ventilation; (5) heat cradle to abdomen to aid in relaxation of the distention process; and (6) the patient should always be blood grouped for possible transfusion if necessary.

It is noteworthy here to remember that good results often are obtained in the patient with ileus by the early use of semi- and solid foods which in turn act to push along the stagnated column of gas.

Since my last case of evisceration two years ago (the one with allergic reaction) I have made a complete change in technic for all of my abdominal repair work. I now use chromic o catgut continuous suture for peritoneum and chromic i catgut interrupted suture for fascia. Also, I now use a reinforced interrupted type of No. 3 Deknatel silk stitch in the fascia. With this type of technic clips are used for approximation of the skin, but very little if any retention type of suture is used.

Since the change in technic of the closure of the abdomen, there have been no unsatisfactory results. All wounds have healed kindly and without serum collections or reactions of any kind. In spite of the occasional postoperative coughing experienced in certain extremely fat individuals and in the presence of debilitating conditions as diabetes and cancer, at no time was there any evidence of delay in wound repair.

Warshaw<sup>3</sup> points out that incomplete evisceration may be very well managed at the bedside, as was done in one of my early case reports. From my observations I am in agreement also with his comment that clean wounds rupture in the young as well as in the old.

McCauliff<sup>6</sup> reports no incidence of wound separation in which muscle retracting incision was used.

In the opinion of Ralph Colp,<sup>7</sup> the crux of the problem seems to rest in failure of regenerative powers of tissues to promote firm healing.

In a study of the absorption of catgut in humans, Wolff and Priestley<sup>8</sup> state that there is practically no difference in the rate of absorption between 20- and 40-day chromic catgut; also that small sizes of catgut last as long as or longer than larger sizes, that single strands last as long as double strands, and that pus wounds do not cause early absorption of catgut.

It would seem to me that in certain cases the serum collections in abdominal wounds are due to catgut absorptive reaction.

#### EXPERIMENTAL WORK

In view of the known controversy concerning allergy, particularly as related to this report, the following experimental work was performed:

The same type of 40-day chromic catgut No. 2, as well as plain catgut No. 1, were taken up into one-tenth normal sodium hydroxide solution by thoroughly grinding and macerating the catgut. This solution was used experimentally in Case XI in order to test the sensitivity of this patient to both chromic and plain catgut. Naturally one-tenth normal sodium hydroxide solution was used as control for all tests. The procedure of the experiment was to inject the catgut solution intradermally into the left arm of the patient and the control solution into the right.

In order to prove my theory of sensitivity more fully, further experimental work was done on ten patients who had had abdominal surgery in which both plain and chromic catgut were used in suturing. Control tests as well as injection of the catgut solution were done in each case. In order to check the experiment further, similar work was done on five individuals who had had no surgery. Each case was carefully observed and repeat tests were done when necessary.

*Results.* On all ten individuals who

had surgery with catgut repair and also on all five who had no surgery, the intradermal hypodermic injection of extracts of the chromic and plain catgut produced no reaction. The control test likewise produced no reaction. The injection of the catgut material always produced an initial white bleb which showed slight inflammatory reaction but which was immediately absorbed without complicating phenomena.

The same experiment performed in Case XI produced different results. The solution of chromic catgut when injected intradermally produced an immediate blanching of the skin in a bleb formation which within five minutes turned a red color and then formed a large pinkish ring approximately four inches in diameter surrounding the site of injection. Neither the plain catgut injection nor the tenth normal sodium hydroxide control solution produced any noteworthy findings. But the chromic catgut injected into Mrs. J. K. produced pain, inflammation and itching in the arm which did not clear up for approximately one week.

To summarize, the findings in this particular case, with experimental evidence and especially the unusual condition of having performed a thyroidectomy on the same patient during the same year followed by rapid healing, would suggest the possibility of defective suture material in the abdominal surgery. The striking feature was that no chromic catgut was used in the thyroidectomy, whereas it was used in the abdominal operation, indicating that the chromic gut was the offending feature in this particular individual. It would be unwise to draw conclusions from just one case, but it supports my belief that there is a certain type of electrocolloidal chemistry present in each individual which may, theoretically, contain a special hyperactive catalytic agent which digests the chromic gut in that particularly sensitive individual. This agent acts to digest the offending catgut quickly which results in evisceration. I believe that this is truly a serious problem confront-

ing all surgeons who perform abdominal surgery.

### CONCLUSIONS\*

1. A case report of a patient allergic to chromic catgut is presented in this report, and, in view of the clinical as well as the experimental facts represented, it is believed that in certain cases allergy plays a part in wound evisceration.

2. The theory is suggested that defective or possibly "allergenic gut" (both of which are quickly digested and absorbed) and also possibly a special unknown chemistry in the wound healing, act together with conditions which cause increased intra-abdominal pressure, to produce the evisceration.

3. From conversations with other surgeons, both at Good Samaritan Hospital as well as other leading hospitals in Los Angeles, it is noted that all wounds of evisceration are resutured with some form of non-absorbable suture material and that usually healing occurs. It would seem that 40-day chromic catgut is actually only a name and that practically there is a great variation in the duration of such catgut.

4. Clean surgical wounds eviscerate in youth just as frequently as in old age.

5. The great majority of evisceration cases are found in patients who have undergone lower abdominal surgery.

6. Evisceration doubles the hospital time for the patient, creates a most embarrassing situation for both patient and physician, and in certain cases results in the death of the patient. It is believed that such a condition should never occur in the physically normal operative case.

7. Deknatel silk stitch has been used in the fascia as a reinforced interrupted type of stitch with marked satisfaction in all forms of abdominal surgery, and it

is believed that this silk stitch gives the operator not only a safe wound closure but one without reaction of any kind.

8. Smaller sizes of chromic catgut are now used because it is believed they are stronger than the larger sizes, and result in a kinder healing process.

9. A majority of these patients were operated upon during Fall and Winter months, but there were no complicating colds or chronic coughs.

Since this paper was completed some time ago, Dr. A. J. Murieta has called my attention to his interesting case operated upon in October, 1942. The patient was a male upon whom Dr. Murieta did an abdominoperineal resection for adenocarcinoma of the rectum. The patient had a normal convalescence; but on the seventh postoperative day there developed a complete evisceration. The wound was clean, all gut stitches were completely absorbed and the wound had the appearance of being digested by some agent. Through-and-through non-absorbable stitches were used to reclose the abdomen. This resulted in satisfactory union and normal convalescence.

This patient had a long standing history of hay fever and the surgical pathological picture in evidence at the time of the evisceration was very suggestive of allergic phenomena related to the complete digestion of the chromic gut.

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\* From considerable observation of hospital records on this subject of evisceration in different hospitals, it would appear that statistics on this surgical condition are very inaccurate. This may be due to incomplete records in closing out charts with surgical complications listed or possibly due at times to an embarrassing condition which the surgeon dislikes to have recorded.

# CIRCUMCISION DRESSING

LIEUT. (J.G.) B. G. CLARKE\*

MEDICAL CORPS, UNITED STATES NAVAL RESERVE

WE present sketches of a dressing for circumcisions which we have employed and found simple and effec-

free end is brought up under a band of one-inch or two-inch gauze roller bandage tied about the patient's waist, and then allowed



FIG. 1. Details of circumcision dressing.

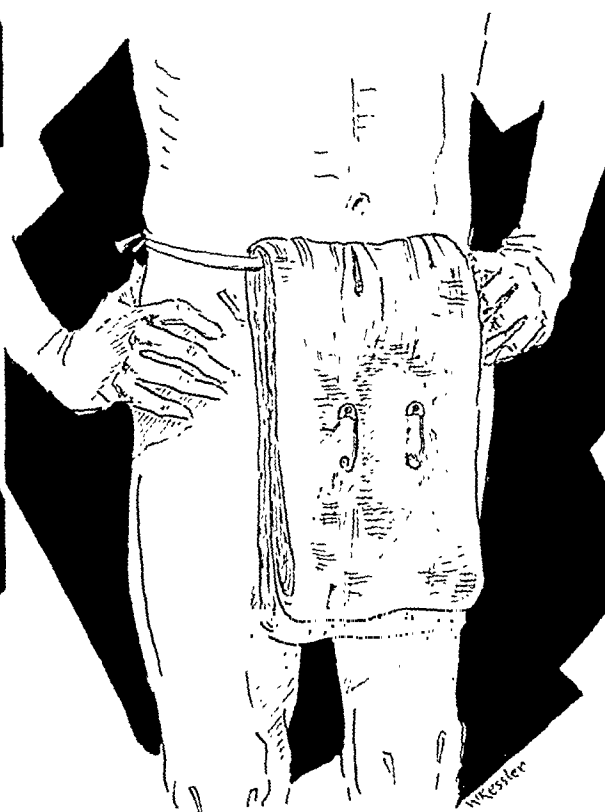


FIG. 2. Dressing in place.

tive enough to deserve description. We do not claim originality but have been unable to discover who first devised the dressing, which was introduced to us by F. L. Pittinger, Pharmacist Mate Second Class, a member of our organization.

Standard thirty-six inch gauze folded in four thicknesses nine inches wide is folded lengthwise on itself to form a long gauze pad nine inches wide, thirty inches long and of twenty-four to thirty-six individual thicknesses. A hole, a couple of inches in diameter, is cut in the middle of the pad about nine inches from one end, through which the penis is slipped. The other, long,

to drop down over the penis which now rests between the two parts of the nine-by-thirty inch gauze pad. Safety pins piercing both parts of the pad on each side of the penis hold it in place between the layers of gauze.

We have performed circumcisions on a number of Naval personnel on shipboard, most of them because of balanitis or constricting prepuce, using a technic under local anesthesia not differing greatly from those described by Bandler<sup>1</sup> and Pugh.<sup>3</sup> The dressing described above has been used successfully in thirty-eight of these cases. Ordinarily, we have wrapped the fresh

\* The drawings in this article were made by Pharmacist's Mate W. W. Kessler, U.S.N.R.

wound with three-inch vaseline gauze strips, then applied the illustrated dry gauze dressing. The vaseline gauze is removed within a few hours or a day, and the dry dressing is used as long as it is needed. Healing occurs rapidly in most cases with no other treatment. Men are able to return promptly to work on deck or in the engine room wearing this dressing under their trousers. According to our observation and to the reports of the patients, the dressing

is comfortable, remains in position well as long as it is pinned, and permits as much activity as the discomfort of the circumcision itself will allow.

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PATHOLOGICAL dislocations are the result of disease and are not treated as traumatic conditions. Congenital dislocations are developmental, and have no relation to traumatism.

From "Fractures and Dislocations for Practitioners," by Edwin O. Geckeler (Williams & Wilkins Company).

# Case Reports

## SCRAPE METHOD OF SKIN GRAFTING

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MEDICAL CORPS, ARMY OF THE UNITED STATES

PROMPTED by the present war emergency, we report what we believe to be an improved method in

of the skin surface was involved between the knee and the ankle. The edges of the ulcerations were serpiginous and sharply defined. The sur-



FIG. 1. Taken prior to first operation indicating exposed bone, muscle, tendon and through and through sinus.

skin grafting. The method is based on the principle that the stratum germinativum is the essential factor in skin regeneration.

### CASE REPORT

The patient, W. C., a male, negro, fifty-seven years of age, was struck on the lower third of his right leg by a casting weighing twenty-five pounds, in November, 1941. An ulceration appeared but was neglected by the patient. The lesion remained localized for about ten weeks and then began to advance rapidly to involve most of the leg in the course of ten days. He was first seen by the authors on February 6, 1942. At that time he appeared acutely ill, was moderately drowsy and responded slowly to questioning.

His temperature was 103°F. The right leg presented extensive confluent ulcerations in the form of large irregular areas of denudation of the skin and subcutanea. About five-sixths

faces of the ulcerations were covered by many large irregular masses of blackish eschar. In addition there were several areas in the intervening skin which were beginning to break down and presented large bullae and diffuse redness and swelling. In one area of ulceration the tendons were exposed. There was a marked stench from the entire leg. The remaining skin was edematous, particularly that of the dorsum of the foot.

Laboratory findings: Kline test negative; white blood cells, 27,000 with polymorphonuclears, 89 per cent; blood sugar 108 mg.; urea nitrogen 19; aerobic culture of the ulcers showed *Staphylococcus albus*, pneumococcus, *Bacillus coli* and *Bacillus tertius*. The anaerobic culture was negative.

The destructive process was progressive for several weeks in spite of high caloric diet, rich vitamin intake, systemic and local therapy with sulfonamides, and other local treatment.

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The ulcerations ultimately produced widespread exposure and partial necrosis of muscles and extensor tendons above the external

sclerosis. The pulsations of the arteries were unobtainable in the right leg and were markedly diminished in the left leg.



FIG. 2. A and B, taken April 14, 1942, three weeks after second skin graft. Note the first and second skin grafts cover areas around knee and ankle, respectively.



FIG. 3. Taken two weeks after third operation. Note multiple islands of skin regeneration over large area.

malleolus. The crest and anterior surface of the tibia became exposed at several levels. A through-and-through sinus tract developed between the tendo achillis and the bones from above the internal malleolus to about two inches above the external malleolus. The temperature still fluctuated between 99 and 102°F.

It was our impression that the progressive nature of the process was probably attributable in part to an underlying peripheral arterio-



FIG. 4. Taken June 12, 1942, just prior to fourth operation.

Eventually the infection and spread of the ulcerations began to yield to treatment, and his general condition started to improve. As an area of ulceration showed improvement an attempt was made to produce skin grafts. After a few preliminary experiments the method described below was evolved and was repeated in three different areas with a satisfactory growth of skin over the entire recipient

surface each time. The attempts to graft were made as soon as the infection was reasonably controlled over a substantial area. Because of

to elapse in order to obtain the tissue in its most active stage of regeneration (later the waiting period was found unnecessary).

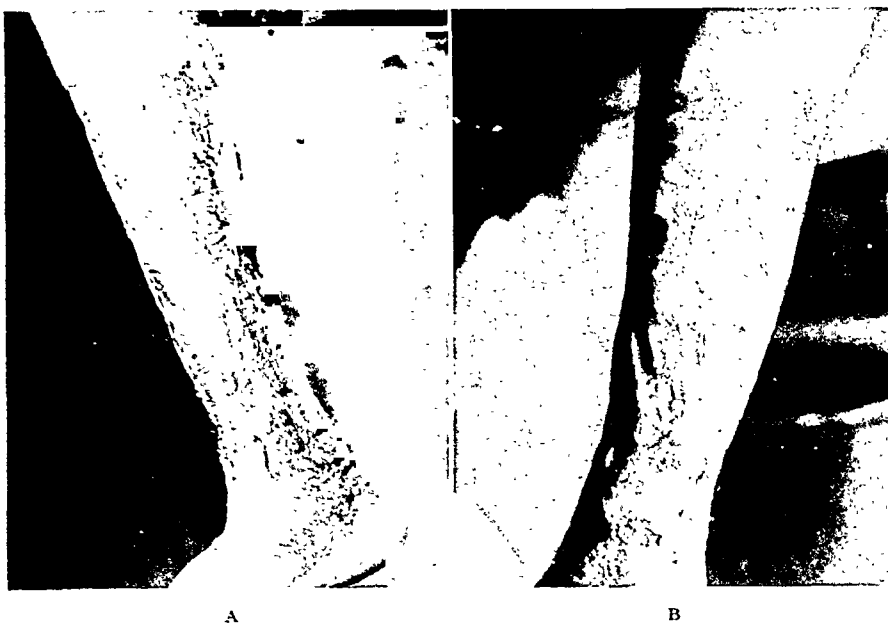


FIG. 5. Taken about three months after patient returned to his regular work; shows entire leg completely healed except for small area on external surface, a few inches above ankle. Marked impairment of circulation probably accounts for the slow healing of this small area as there is a similar ulcer on the opposite leg. The rough appearance of the leg is due largely to the impressions made by an elastic circular bandage which was removed just prior to photography.

the continued suppuration and sloughing in several areas of the leg, the four operations had to be spread over several months.

Shortly after the last skin grafting the entire leg was covered with adequate skin except for a small area above the external malleolus. Marked impairment of circulation probably was responsible for the slow healing of this small area as there was a similar small ulcer on the opposite leg. This man returned to his former job on August 17, 1942, and has worked continuously since. He had a moderate limp at first which gradually disappeared completely.

#### PROCEDURE

The material employed for grafting was obtained in the form of bran-like flakes. After skin preparation for sterility the superficial layers of the donor area were pared away by gentle scraping with a sharp scalpel or razor blade until slight oozing appeared. In the initial experiments a period of five days was permitted

The donor area was then scraped again in the same manner as previously but to a greater depth. This was best done under light general anesthesia with vinethene. The scrapings were then thoroughly mixed into a sterile solution of acacia to form a jelly. This mixture was then smeared with a tongue depressor over the recipient area. The latter had been prepared just prior to the graft by removal of redundant granulations with a scalpel to provide a smooth bed of healthy tissue. Following the application of the acacia mixture the entire area was dusted lightly with sulfathiazole powder. The scrapings were retained *in situ* by apposition of circular bandages impregnated with scarlet red. These were thickly overlaid with gauze compresses and an outer circular bandage was applied snugly. The extremity was then immobilized on a pillow splint with sandbags. The dressing was not changed until the fourth or fifth day.

The donor area was dusted heavily with sulfathiazole powder and a dry dressing was applied. The area was not redressed until it was presumed to be entirely healed.

The above method was employed four times, twice at the hospital and twice at the patient's home. The last two times the graft was made directly after paring the superficial layers of epidermis. The five-day waiting period was thereby dispensed with. This facilitated the procedure and the results appeared more satisfactory than in the original method.

In addition to rapid skin regeneration following this method, it was also noted that the above procedure produces remarkable control of infection, represented by rapid striking decrease in discharge and odor. It appeared that the greater the concentration of red blood cells that were smeared on an infected area the more noticeable was this effect. However, a special effort was made to keep the bleeding to a minimum.

The authors are unable to explain this unexpected phenomenon but it is their belief that the blood cells in combination with either serum and skin or alone manifest some inherent inhibitory factor to infection, yet unknown and unexplained. The presence of this factor in healthy tissue

may explain why such tissue frequently offers a variable resistance to infection. The greater the concentration of this factor the greater the resistance to be expected.

#### COMMENTS

The advantages of this method may be listed as follows:

1. The procedure is simple. Only a few instruments are necessary, scalpel or razor blade, tongue depressor, medicine glass, and acacia (acacia helpful but not essential). The donor area is scraped twice, the deeper scrapings are mixed with sterile acacia and spread on the recipient area.
2. It can be performed speedily.
3. Prompt and satisfactory regeneration of the transplants is obtained.
4. It may be useful in treating infections.
5. The area from which the scrapings are obtained heals promptly without scarring.
6. The method may have further application in plastic surgery and in the healing of burns and war wounds when skin has to be matched with that of the opposite side of the body.
7. The possibility of employing this method immediately after skin injury (as in war wounds) is deserving of consideration.



# VARICOSE VEINS OF THE ABDOMINAL WALL

## REPORT OF A CASE DEMONSTRATED BY INFRA-RED PHOTOGRAPHY

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THE paucity of reports in the literature with regard to abdominal wall varices bespeaks the rarity of this condition. A sufficient number of cases has not been observed to permit conclusions concerning their etiology, and for the same reason there has been no standardization of treatment. However, there are many theories of origin of varicose veins which may apply to those of the abdominal wall as well as to those of the leg. It may be of value then to consider the theories of origin of varicose veins, to review the anatomy of the abdominal wall veins and to present an illustrative case.

In 1934, Froehlich<sup>1</sup> reported that abdominal wall varices were observed in about 1 per cent of the cases of varicose veins of the legs treated in the Vein and Ulcer Clinic of the Minneapolis General Hospital. This incidence has not been confirmed in the literature or in the present author's experience with approximately 500 cases of leg varices. In the one case to be reported at this time there was not a semblance of varicosity in any leg vein. Large, prominent normal veins are seen often in the abdominal wall, particularly in thin individuals and in conjunction with prominent veins elsewhere in the body. Enlarged or engorged abdominal veins are seen not uncommonly where there is portal obstruction or in iliac vein obstruction especially secondary to deep phlebotrombosis in the lower extremities. But these should not be designated as varicose veins in spite of the usual definition of a varicose vein as simply an "enlargement or dilatation of a vein." We shall refer here only to spontaneous, local venous enlargement characterized by tortuosity or sacculation.

### THEORIES OF CAUSATION OF VARICOSE VEINS

Evidence offered by the present knowledge of the causation of varicose veins is not conclusive. The theory that varicose veins of the legs are contributed to by man's erect posture has many proponents. This is the popular explanation of Delbet who says that back pressure from the iliac veins causes the valves at the saphenofemoral junction to give way. Loss of valve function is the first step; dilatation of the vein is next. Almost exclusive occurrence of varicose veins in adult life is consistent with the fact that fewer valves are present in adult life than at birth. The same theory may hold in explaining simultaneous abdominal wall varices (if increased intravenous pressure is the important factor) since the superficial veins of the abdomen are tributaries of the great saphenous vein. However, in contradiction of the theory of increased intravenous pressure, McPheeters<sup>2</sup> has shown that varicose veins of the leg persist in spite of reduction of intravenous pressure by ligation of the great saphenous vein at the saphenofemoral junction. Furthermore, there may be severe unilateral varicose veins without the presence of varicosities in the other leg. If posture and increased intravenous pressure are etiological, the varicosities should appear bilaterally.

There is much in favor of another theory that formation of varicose veins is but one evidence of a general connective tissue weakness throughout the body. This is a progressive degenerative process which might apply in the case of persons of middle age or after. Another theory claims etiology or contribution by vitamin c deficiency; this would, according to the

rôle of vitamin c in the body, place this theory and the previous one on somewhat common ground. endocrine, vitamin, constitutional (hereditary) or other factor. Aggravation by posture, increased intravenous pressure or

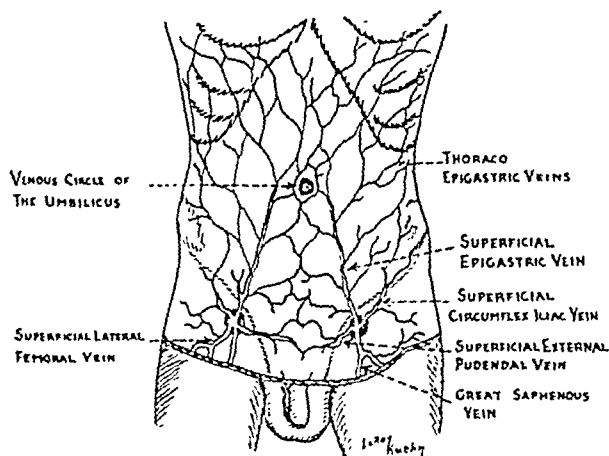


FIG. 1. The superficial veins of the abdomen and groin (modified from Toldt).

There is also the theory of an endocrine factor, based upon the observation that varicose veins are more common during pregnancy. This theory refers to primary dilatation in which the factor of pressure from a gravid uterus has been ruled out or in which venous enlargement occurs before the uterus has reached a size sufficient to produce pressure. It might carry more weight if it could explain the occurrence of varicose veins in men.

None of the above theories, however, explains the occurrence of isolated varices in remote portions of the body. For instance, the rare occurrence of a varicosity has been noted by the author over one supra-orbital ridge, also in a tributary of the cephalic vein over the biceps muscle of the upper arm, and in another case in the mucosa of the lip. In considering abdominal varices, Sarma<sup>3</sup> speaks of them in conjunction with varicosities of the legs and regards them as "leg" veins which run an upward course. McLaughlin<sup>4</sup> states that dilated veins in the lower part of the abdomen result from changes in the vessel walls similar to those occurring in varicose veins elsewhere. Spontaneous change in the vessel wall logically appears to be the initial step, whether or not there is an

other state may then occur; but the primary tendency appears to be in the vein wall itself. When elasticity is lost, sacculatation and tortuosity occur. Further support of this contention is gained from the observation that localized sacculations, aneurysmal in appearance, often occur in leg veins in which there is no incompetence of valves above the sacculatation. Still further support should be derived from the occurrence of uncomplicated, isolated varicosities of the abdominal wall.

#### ANATOMY OF THE SUPERFICIAL VEINS OF THE ABDOMEN

The veins which may be involved in varicosities are the superficial epigastric, the superficial circumflex iliac, and the superficial external pudendal. (Fig. 1.)

The flow in these veins is downward into the femoral vein via the great saphenous vein. They may enter the saphenous vein individually or by a variable combination of trunks very close to the sapheno-femoral junction. The superficial epigastric veins are the largest and most constant; they are almost always encountered in the medial portion of the oblique incision made for inguinal hernia repair. These veins possess extensive anastomoses. There is

anastomosis between the superficial circumflex iliac and the superficial lateral femoral, between the superficial epigastric and the deep epigastric vein which in turn anastomoses with the para-umbilical veins which empty into the portal system.

The para-umbilical veins lie in or just superficial to the peritoneum adjacent to the umbilicus and to the round ligament of the liver; they are sometimes known as the accessory portal veins of Sappey. Anastomosing with these is a more superficial anastomotic chain of small veins known as the "venous circle of the umbilicus" (Toldt). The enlargement of these veins in portal obstruction constitutes what is known as "caput medusae." The superficial epigastric veins also have connection with the thoraco-epigastric veins which are small veins arising in the region drained by the smaller tributaries of the superficial epigastrics (or may be directly continuous with the latter). The thoraco-epigastrics carry blood superiorward on each side of the trunk and eventually empty into the axillary veins. Anastomoses also exist between the superficial epigastrics and the internal mammary veins. It is easily seen then that portal drainage is toward the axilla and the internal mammary veins as well as toward the groin in portal obstruction; and drainage of the abdominal wall in femoral or iliac obstruction may be through the accessory portal system. The foregoing knowledge should be taken into consideration in the treatment of abdominal wall varices.

#### CASE REPORT

The patient, a twenty-three year old white female, was employed as a stenographer. She complained only of varicose veins of the abdomen which at times caused pain. These veins appeared about four years previously and began recently to enlarge, first on the left and then on the right side. There was some pain on the left side near the groin in the erect position, none in the supine position. She noticed that the veins were not filled in the supine position and that they filled and caused slight pain on straining. There had never been

any inflammation, induration or evidence of thrombosis anywhere in the course of the enlarged veins. There had never been enlarged

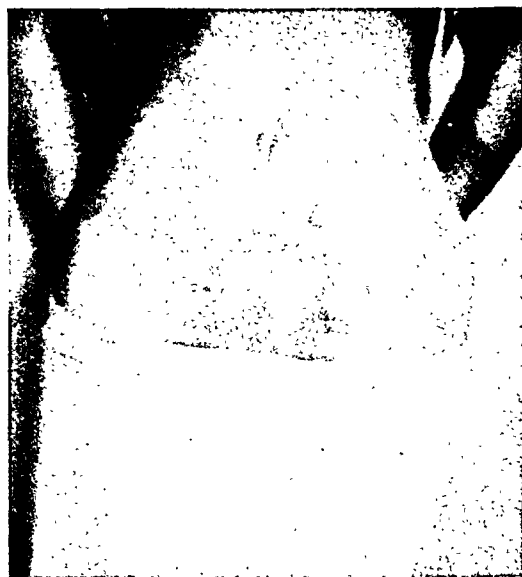


FIG. 2. Infra-red photograph demonstrating varicose veins of lower abdomen.

veins of the lower extremities or symptoms of phlebothrombosis of the legs nor had there been dyspnea or swelling of the abdomen or of the ankles.

The only significant feature was the history of a shelf operation for congenital dislocation of the left hip, performed approximately six months prior to the appearance of the varices. There was an uneventful convalescence, and at no time in the postoperative period was there evidence of vascular obstruction in the groin or lower extremities. (Fig. 2.)

Both superficial epigastric veins were greatly enlarged and tortuous in the lower half of the abdomen. A large, tortuous collateral ran transversely from the right to the superior portion of the enlargement of the left superficial epigastric vein. The dilatation of both epigastrics ended abruptly at the groin. The veins emptied completely in the supine position and filled on sitting or standing. There was incomplete filling when both superficial epigastrics were compressed at the groin.

The liver edge was just palpable on deep inspiration; the spleen was not palpable. There was no ascites and no palpable masses. There was about 80 per cent of normal range of motion in the left hip and there was no pain or tenderness. There was a long scar on the lateral aspect of the left hip resulting from the shelf operation. No dilatation of any degree was found in any of the veins of the thighs or

legs. On pelvic examination the uterus and adnexae presented no palpable pathological change.

Under local anesthesia and through short incisions the veins were ligated and severed just superior to each inguinal ligament and at the junction of the left superficial epigastric with the horizontal collateral at which point there seemed to be a deep communication. The patient was allowed to be ambulatory and suffered no discomfort. Spontaneous thrombosis occurred throughout the varicosities and eliminated the need for sclerosing therapy. Multiple ligation was decided upon in preference to injection therapy alone as a safer and more permanent treatment which could be supplemented by injection therapy if necessary. An infra-red photograph (Fig. 2) was of help in demonstrating the morphology of the varices and in determining the points to be ligated. It is believed that the possibility of embolism through the portal system and through the femoral veins was minimized by preliminary ligation. Six months later the veins remained completely obliterated and asymptomatic.

#### SUMMARY

1. Some of the theories of formation of varicose veins have been presented.

2. The anatomy of the superficial veins of the abdomen has been discussed, especially with reference to anastomoses.

3. A case of uncomplicated varicose veins of the abdominal wall, without occurrence of varicosities elsewhere, has been reported.

4. Infra-red photography is a valuable adjunct in demonstrating the extent and connections of varicose veins. It may help in deciding the points at which ligations are to be done.

5. Preliminary ligation or ligation alone (as in the case presented) is the preferred treatment, because embolism seems less likely than when injection treatment alone is employed. Recurrence also is less likely.

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# APPENDICITIS INCARCERATED IN A FEMORAL HERNIA

## CASE REPORT

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AND

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THE Indicus Medicus has been reviewed for a period of ten years, from 1932 to 1943, both under femoral hernias and under appendix, and no reference to a case of the type herein reported could be found. We, therefore, submit this case as a first reported operation of an appendix incarcerated in a femoral hernia.

### CASE REPORT

The patient, L. J. No. 39375, had a lump in the right groin for one year. About one year ago, with no known preceding etiology or trauma, the patient noticed a small lump in his right groin, which was neither painful nor tender. There had been no associated symptoms until ten days prior to admission, when the mass became suddenly larger and tender. There was a sharp pain on flexion of the body. The pain did not radiate and became constant twenty-four hours prior to admission. The bowels were regular and normal, and there never had been signs of obstruction or strangulation. There were no urinary complaints. Review of symptoms was entirely negative except for local condition. Two years previously the patient had an episode of acute cystitis which responded well to treatment.

Physical examination revealed the patient to be a well developed, well nourished, sixty-two year old white male, who did not appear ill. In the right groin, lateral to the pubic spine, there was an elongated, egg-sized, tense, and moderately tender mass, which was smooth and fixed and not reducible. The external inguinal ring was dilated but no impulse could be felt on coughing or straining. With the examining finger inside the external inguinal ring, the mass seemed to be entirely lateral to the canal wall. The left inguinal ring was also dilated, but no hernia was found. Blood pressure was 144/90. The abdomen was soft and not distended. No organs were palpable,

and there was no tenderness. The extremities showed no edema or cyanosis.

*Admission diagnosis* was right femoral hernia, incarcerated.

Urinalysis was negative. The white blood count was 9,400 with 79 per cent polymorphonuclears. The case was considered operable, and with a preoperative diagnosis the same as the admission diagnosis, repair of the femoral hernia was attempted under avertin, gas-oxygen-ether anesthesia.

There was a femoral hernia about 4 cm. by 4 cm., oval in shape, tense, with the peritoneal fat over it hemorrhagic and friable. It was filled with straw-colored fluid and the vermiform appendix which was swollen, edematous, marked in a punctate fashion with dark hemorrhagic areas. The meso-appendix at the tip of the appendix was swollen to about 2 cm. in diameter and medial to this was thinned out. Even after removal of the swollen portion of the meso-appendix, the appendix could not be reduced. After opening the upper abdomen, all but about 1 cm. of the appendix was seen to be in the sac. The appendiceal artery entered the appendix through the mesentery about  $\frac{1}{2}$  cm. from the base. After reducing the appendix by traction above, and pushing from below through the lower wound, the hernial orifice would not admit the little finger. The cecum was attached well down by peritoneal reflections to the lateral and posterior abdominal wall.

A three-inch incision was made below and parallel to Poupart's ligament over the mass. The skin was walled off by towels, dissection was carried down to the sac, the sac was opened, the appendix was seen to be in the sac and was apparently acute; an unsuccessful attempt was made to reduce it. The meso-appendix within the sac was ligated and excised from the appendix, and still the appendix could not be reduced, nor could the cecum be pulled through the neck of the sac. A low McBurney



incision was then made, and the appendix was delivered by traction from above with a moderate amount of pressure from below. The sac neck was so tight that the muscularis of the appendix was divided about an inch from the base in its entire circumference, but the mucosa was not torn. The appendix was removed by ligation and division of the remaining meso-appendix to the base, clamp and cautery, with inversion of the stump through a linen purse-string. A figure-of-eight catgut on an atraumatic needle was placed over the inversion. The peritoneum was then closed by a continuous plain catgut suture. The transversalis, internal oblique, and external oblique were closed by interrupted No. 1 plain catgut sutures. The superficial fascia was closed by fine interrupted plain catgut, and interrupted silk was used for the skin. The hernial sac was then dissected down to its base, ligated, and removed. The stump of the sac was retracted well inside of the ring. One No. 2 chromic suture was used to close the opening of the ring which would not admit the tip of the little finger. The hemorrhagic properitoneal fat which had been dissected from the sac was removed, and the deep areas of the wound

were closed by interrupted sutures of No. 0 plain catgut. Another layer of interrupted sutures was placed in the superficial fascia, and interrupted silk was used for the skin.

The specimen showed a femoral hernia sac, appendix, meso-appendix and fat. The appendix was 8 cm. long and 1 cm. wide; its serosa was rough, congested and denuded in the midline.

The appendix was much thickened by old connective tissue. The epithelium was actively secreting mucus. There was some lymphocytic exudate and some eosinophilic infiltration but no pus. The peritoneal coat contained greatly engorged blood vessels but showed a very minor inflammatory reaction. Various parts of the accompanying pieces of tissue were congested fat, or fat with some productive connective tissue as in adhesions, also congested but only mildly inflamed.

Diagnosis: Chronic appendicitis with recent peri-appendiceal congestion; congested omental or meso-appendix adhesions.

His postoperative course was uneventful; the sutures were removed on the eighth day and the patient was discharged as cured on the sixteenth day.



# BENIGN PAPILLOMA OF THE AMPULLA OF VATER

## CASE REPORT

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AND

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WHILE benign neoplasms of the ampulla of Vater are relatively rare, as compared to carcinoma with or without involvement of the pancreas, they probably should be considered more seriously when attempting to make a diagnosis of obstructive jaundice.

In 1936, Baggenstoss<sup>1</sup> reported twenty-five cases of polyp of the major papilla from the autopsies recorded at the Mayo Clinic. None were diagnosed before death and the reason for these patients coming to the clinic seemed to have had no relation to the papillomas found at autopsy, but from this report it may be assumed that papilloma of the ampulla is more common than we have believed. Baggenstoss also reported two cases of adenoma of the ampulla of Vater, described by Calzanara in 1895, one was removed by Stein, and another by Archibald.

Christopher<sup>2</sup> collected forty-one cases, with benign growths and added one of his own, in which an adenoma of the ampulla was found. Of the forty-five cases, sixteen were papillomas or polyps, fifteen adenomas, fourteen lipomas, two fibromas, two neuromas, two granulomas, and one a carcinoid.

Waters<sup>3</sup> stated that as late as 1930, only four of the reported benign tumors of the duodenum had been diagnosed by x-ray.

Horsley,<sup>4</sup> in 1941, reported on a case in which a one-stage resection of the duodenum was performed for tumor of the ampulla of Vater. Death occurred on the fourth postoperative day and the pathological report revealed an adenomatous structure, with no evidence of malignancy. This case, as does the case being reported, suggests the rational of opening

the duodenum and either removing the growth, if it appears benign or if in doubt, obtaining a biopsy before a radical resection of the duodenum and head of the pancreas is done. At this time, the gallbladder or common duct should be anastomosed to either the stomach or jejunum. This later becomes the first stage of the radical operation, if it is necessary.

Cooper<sup>5</sup> states that, "no single operative procedure is suited to all varieties of tumor of the ampulla of Vater. If the tumor is a small papilloma, free of ulceration, and more or less pedunculated, without infiltration at its base, transduodenal resection with reimplantation of the ducts should be the ultimate procedure; while if the tumor is definitely malignant and infiltrates the duodenal wall, transduodenal resection obviously is not the procedure of choice and the radical operation should be attempted." This appears to me to be a sound approach to this very difficult problem.

## CASE REPORT

A fifty-nine year old man was admitted to Emory University Hospital January 30, 1942, complaining of jaundice, anorexia and weakness. The jaundice had been present for a period of three months and had become much more intense during the week prior to admission. He had complained of pain only once and then, it was of short duration; stools had been clay-colored for two months; nausea and vomiting had first occurred three days before admission; he had complained of weakness since the onset of jaundice, and had lost approximately twenty pounds in weight.

Physical examination revealed an intensely jaundiced individual; the abdomen was soft, there was no tenderness and no mass was felt;

liver edge could be palpated about two and one-half finger breadths below the right costal margin; the gallbladder was not palpable; his temperature was normal.

mass could be felt in the duodenum or in the head of the pancreas and it was my impression, that we were probably dealing with a silent common duct stone. The patient's condition

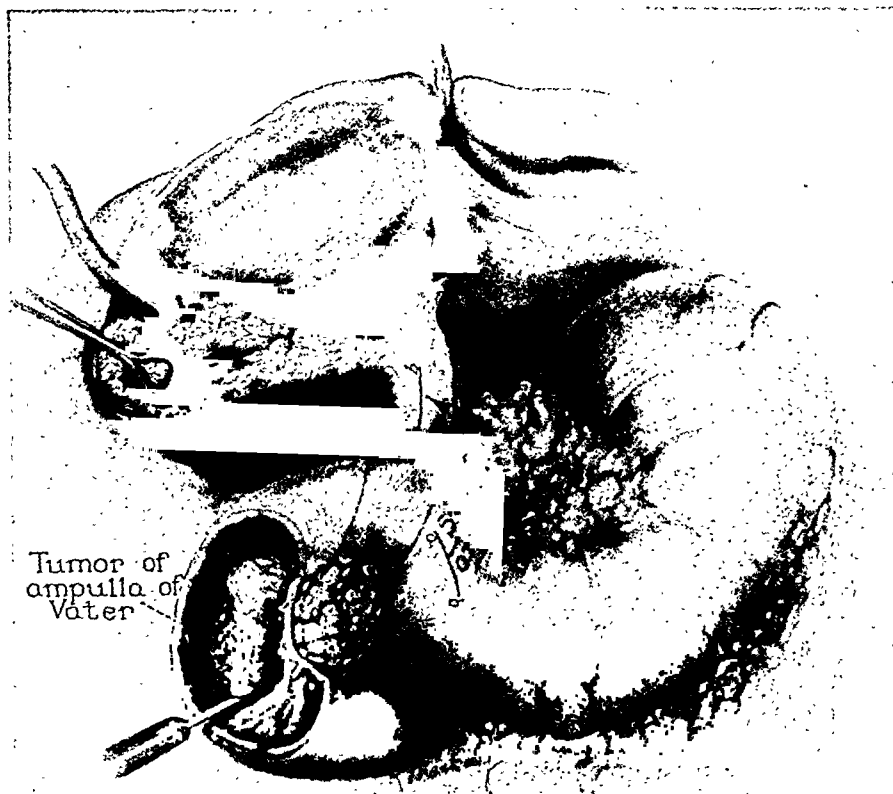


FIG. 1. Tumor of the ampulla of Vater.

Laboratory studies revealed the following: urine negative; red blood cells 4,200,222; hemoglobin 84 per cent; white blood cells 6,120 with normal differential; blood non-protein nitrogen, urea, sugar and creatinine normal; icteric index 30; direct Van den Bergh's was positive with 4.12 mg. bilirubin per 100 cc. serum; blood amylose 620; and the stools were persistently negative for bile. A preoperative diagnosis of obstructive jaundice, probably due to malignancy involving the head of the pancreas was made.

The patient was prepared for operation with intravenous infusions of glucose and saline, vitamin K, liver extract, along with transfusions; and on February 5, 1942, with intravenous sodium-pentothal, supplemented by nitrous oxide gas, for anesthesia, he was explored through a right subcostal incision. Instead of finding an enlarged thin walled gallbladder, the gallbladder was somewhat thickened, as was the common duct; no definite

was not very satisfactory, so a two-stage procedure was decided upon and a cholecystectomy was done, as the first stage. Following this operation, he drained bile freely and his jaundice rapidly cleared. With the bile being replaced through a Levine tube, his appetite improved; he gained weight, and his general condition became so satisfactory, that on March 13, 1942, he was again explored for a common duct stone through a right paramesial incision.

The common duct was opened and was found to be obstructed, but no stone could be felt. The second portion of the duodenum was then opened through its anterior wall, exposing what appeared to be a papilloma, the size of a walnut, growing in and completely obstructing the ampulla. While it was growing from a broad base, it did not appear to infiltrate extensively the duodenal wall or pancreas and was easily excised with the Bovie blade. The bleeding was controlled with a continuous locking stitch of

fine catgut and the incision in the anterior wall of the duodenum was closed transversely. An incision was then made in the anterior wall of the stomach to correspond in length to the incision in the common duct, and a side-to-side anastomosis, over a small rubber tube, was made between the common duct and the anterior wall of the stomach. This was easily accomplished without tension. The tube in the gallbladder was allowed to remain and the abdomen was closed. Bile was removed from the stomach through the Levine tube the following day, proving that the anastomosis was functioning. By the end of the third day, there was no bile draining from the gallbladder. The tube was then removed and the sinus promptly closed. The patient's convalescence was uneventful. He continued to gain weight; bile was present in his stools; there was no evidence of recurrence of jaundice and he was dismissed from the hospital, ambulatory, March 30, 1942.

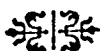
It has been fourteen months since patient was dismissed from the hospital and he has remained entirely well. His normal weight has been maintained, there has been no recurrence

of jaundice and he has shown no symptoms that would suggest regurgitation of the gastric contents into the biliary ducts.\*

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\* At the time this manuscript was presented, the patient appeared to be in normal good health but, a short time ago, he began to lose weight and examination showed what was believed to be a metastatic lesion, involving his lungs, from which he recently died. An autopsy could not be obtained and we are unable to state the exact cause of death. He did not develop jaundice and we have no good reason to believe that the malignancy that caused his death originated from the growth in the ampulla. I might add that these slides have since been reviewed and we could find no evidence of malignancy.



# UNION OF PATHOLOGIC FRACTURE OF FEMUR FOLLOWING CASTRATIONS FOR CARCINOMA OF THE PROSTATE\*

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THE experimental and clinical work of Huggins and his co-workers<sup>1</sup> and of numerous other investigators have firmly established the value of castration in the treatment of carcinoma of the prostate gland. The improvement resulting from this type of treatment has not been confined to the primary lesion in the prostate, but has been evident in metastatic lesions. Although the medical literature describes numerous instances of disappearance of bony metastases, there is no reference to healing of a pathologic fracture.

In the present case, a pathologic fracture of the femur showed no evidence of union until bilateral orchidectomy was done fourteen weeks after the fracture occurred. Of additional interest is the accompanying disappearance of the symptoms of obstruction to urination, a reduction in the amount of residual urine, and a regression in the size of the prostate gland as palpated by rectum.

## CASE REPORT

This seventy-six year old man was admitted to the hospital on March 27, 1941. One hour previously, after suddenly turning around from a sitting position on a chair, he felt a severe pain in the left thigh. On attempting to arise, he experienced buckling of the injured thigh and was unable to support himself.

The medical history revealed no past illnesses nor complaints of significance except for increasing difficulty of urination, nocturia six to eight times, and dribbling. There had been no total retention of urine.

Blood pressure was 162/94; temperature: 98.6°F., pulse, 76; respirations, 22; moderate

obesity. The definite abnormal findings were a small umbilical hernia, outward rotation and hypermobility of the left thigh, indicative of fracture of the left femur; arthritic deformity of fingers of both hands; moderate enlargement of the prostate gland as palpated by rectum, with the fixation and hardness of prostatic carcinoma.

The urine was straw color with an acid reaction; specific gravity 1011; albumin: 1 plus; sugar; negative. Microscopically, a few pus cells and innumerable red cells were found. Hemoglobin was 86 per cent; red blood cells 4,490,000; white blood cells 9,300; differential: 69 per cent polymorphonuclears, 31 per cent lymphocytes; blood urea nitrogen 25.3 mg.; creatinine: 3.6 mg.; blood Wassermann, negative.

A portable roentgenogram of the left hip on the day of admission was reported as follows: "There is a fracture involving the upper end of the left femur just below the trochanteric region. The fragments are in fairly good position. There is some rarefaction involving the shaft of the bone at the fracture site, the appearance being quite suggestive that the fracture is pathologic in nature and probably due to metastatic involvement of the bone."

The fracture was treated conservatively with light traction. Another roentgenogram (Fig. 1), May 23, 1941, (almost two months after the injury) was reported as follows: "There is rather extensive decalcification apparent about the lateral side of the innominate bone including the pubic rami, the acetabulum and upper femur. There is a deformity just below the lesser trochanter which is probably a pathologic fracture with formation of considerable new bone on either side."

About one month after the patient's hospital admission, the voided urine became grossly

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bloody, necessitating frequent bladder lavage for the removal of clots. A residual urine of 260 cc. was obtained by catheter. The urologic

care. Because of improvement he considered further care unnecessary.

Only after a determined search was he found



FIG. 1. Roentgenogram of left hip taken two months after the accident, showing the pathologic fracture with no evidence of union.

consultant at that time described the prostate as "large, hard, encroaching on the urethra, and probably carcinomatous" as palpated by rectum.

Almost four months after hospitalization, I examined the patient and decided on the basis of rectal palpation, that there was unquestionably a prostatic carcinoma. Bilateral orchidectomy was suggested as a means of improving urinary symptoms. Although transurethral resection of the bladder neck obstruction was considered, it was not done. The patient's relatives objected to further surgery because of his debility.

On July 14, 1941, (three and one-half months after the fracture occurred) bilateral orchidectomy was done under spinal anesthesia through incisions in the lower inguinal region. At the conclusion of the operation, a catheter was tied in the urethra. This was considered necessary because the urine was grossly purulent, and could well have contaminated the wounds. Convalescence was uneventful, and the patient was discharged from the hospital twenty-four days following the operation.

No accurate account of his condition was obtained for several months after hospital discharge because he never sought medical

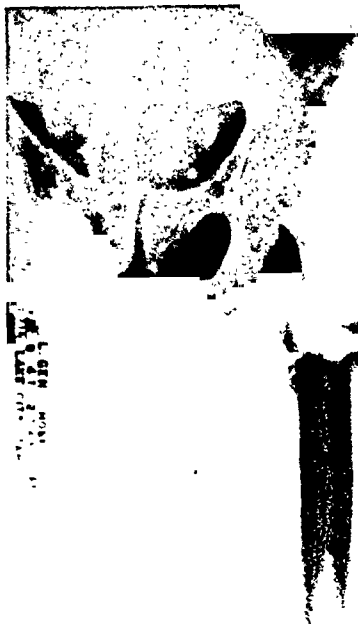


FIG. 2. Roentgenogram of left hip fifteen days after bilateral orchidectomy. Described by roentgenologist as showing "considerable decalcification of the head, neck, trochanters and upper end of the shaft."

and brought to the hospital for a general examination. Union of the fracture had progressed sufficiently to permit walking with the aid of crutches. He did not complain of bladder dysfunction. One ounce of residual urine was obtained by catheter immediately after he had voided. Palpation of the prostate by rectum revealed a regression by volume to a small fraction of its previous size. The hardness of malignancy remained in an atrophic lobe to the left of the median sulcus but the remainder of the gland was of the consistency of normal prostate, and hardly protruded into the rectum.

Additional roentgenograms of April 13, 1942 (Fig. 3), were reported as follows by the radiologist: "Comparison of the film with the previous examination of July 29, 1941, demonstrates that the fragments of the femur have firmly united in good position and with a moderate amount of callus formation. There is no evidence of any metastatic process involving either the lumbar spine or the bones of the pelvis."

No further examination was done until the patient was admitted to the hospital on Jan-

uary 29, 1943. Five days before, he had complained of a sudden severe pain in the left occipital region. He rapidly became very weak



FIG. 3. Roentgenogram of both hips nine months after castration. Solid bony union of fracture of left hip.

and dyspneic. There was no evidence of impaired function of his extremities. He remained mentally clear for two days, but then fell into a progressively deeper stupor. Death occurred shortly after admission. Only a cursory examination was possible. No new findings were disclosed. Rectal examination revealed further reduction in the size of the prostate gland. By questioning the relatives, it was determined that the patient had been in good health

following the last examination. He had been able to walk with the use of a cane. Urination was unimpeded. He had shown a moderate weight gain and had increased vitality. Permission for an autopsy was not granted.

#### SUMMARY

A seventy-six year old male sustained a pathologic fracture of the femur. Physical examination revealed a carcinoma of the prostate gland. There was no roentgenologic evidence of union of the fracture after three months of traction. Bilateral orchidectomy was done but no attempt was made to remove the malignancy of the prostate. Subsequent roentgenograms showed solid union of the fracture eleven months after the orchidectomy. There was a concomitant disappearance of obstruction to urination and a great reduction in the size of the prostate as palpated by rectum. Death occurred twenty months after the orchidectomy, probably of a cerebral vascular accident.

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# BILATERAL SIMULTANEOUS TUBAL PREGNANCY\*

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IN searching through the literature we found that bilateral simultaneous tubal pregnancy is of rare occurrence. We had bearing down pain in both lower quadrants and a feeling of fullness in the pelvis. She also complained of dysuria. The staining increased



FIG. 1. Bilateral simultaneous tubal pregnancy.

feel justified, therefore, in reporting an additional authentic case.

## CASE REPORT

M. K., a colored, female, married, age thirty, was admitted to the hospital on November 17, 1941. She was married five years, had no children, miscarriages or abortions. Menstruation began at age of fourteen, was of the regular twenty-eight-day type, lasting four days with occasional pain. She gave a history of a period on October 17, 1941, lasting one day instead of the usual four days.

On November 16th, she began to stain and

in amount and was dark in color. She felt nauseated but did not vomit. Then pain began. Physical examination revealed a fairly well developed and well nourished, colored female. The abdomen was somewhat distended and tense and rather tender to palpation. A round, indefinite mass was palpable in the lower right quadrant. There was marked rigidity in both sides. Pelvic examination revealed a good pelvic floor and dark bloody discharge. The uterus was somewhat fixed and slightly enlarged. There was a fixed and tender mass the size of an orange in the right adnexal region. A smaller palpable mass was felt in the left side.

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A tentative diagnosis of bilateral chronic salpingitis and possible ectopic pregnancy was made.

Laboratory findings were: Leucocytes—13,200; red blood cells 4,100,000; hemoglobin—80 per cent; temperature—101°F.; pulse—82; respiration—26; urine was normal; sedimentation rate was 18 mm. in twenty-seven minutes.

We decided upon a conservative course and careful observation for several days. The patient's condition did not improve under conservative treatment; pain increased in intensity and staining did not stop, and it was deemed advisable to perform a laparotomy.

On November 25, 1941, a laparotomy was performed under spinal anesthesia. The peritoneal cavity contained no fluid or blood. An orange-sized mass was found in the right adnexal region matter together, right tube, ovary and omentum. In the left adnexal region the tube was swollen and contained a bluish, walnut-sized mass in the midportion of the tube. The left ovary contained a corpus luteum. Operation consisted of a right salpingo-oophorectomy and left salpingectomy.

The postoperative course was uneventful. The patient was discharged on the twelfth day in good condition.

Macroscopically, the right tube was irregular in outline; the center was elevated. It contained

a hemorrhagic mass suggesting placental tissue. There was a fetus 2 cm. with cord. The left tube was 10 by 3 cm., irregular in outline and contained in the center midportion a bluish cystic mass 4 by 5 cm., and a small pinkish grey structure was seen adherent to the mucosal surface of the tube. This grossly suggested placental tissue.

Microscopic examination revealed that in the lumen of the tubes there was blood and chorionic villi and decidual cells. The chorionic villi were attached to the walls and free in the blood clot of the lumen. The villi were in a dissimilar developmental stage in both tubes. Through the wall were areas of hemorrhage; the blood vessels were dilated and congested. Extensive hemorrhage likewise had occurred into the interstitial tissue. In places the normal mucosa had disappeared and there was loose pseudodecidual reaction which had replaced the underlying stroma. Throughout the ovary there was marked fibrosis and cysts that were lined by several layers of epithelial cells resting on a basement membrane of fibrous connected tissue and round cells.

#### COMMENT

The variation in size of tubes and developmental dissimilarity of the chorionic villi strongly suggests a superfetation.



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# The American Journal of Surgery

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## Editorial

### MEDICAL CONTROL

WHILE a majority of the members of the medical profession in this country are concerned and apprehensive of the proposed Wagner-Murray-Dingell bill and all it implies, Dr. Betram M. Bernheim, associate professor of surgery at the Johns Hopkins University Medical School and author of "Medicine at the Crossroads," presented on February 25th, before the Physicians Forum, at the Kips Bay Health Center, a program for what he termed "tomorrow's medicine," and outlined eight vital objectives aiming to place medical practice on a *sound foundation*. These objectives would provide equitable distribution of physicians, guarantee the physician's economic security and provide adequate medical care to the masses of the people.

Dr. Bernheim said that the majority of the medical profession fear a medical "dictator" and in order to eliminate this fear he suggests a five-man mixed Federal medical commission, three doctors and two laymen, who will have charge of administering medical practice throughout the country. This commission would be appointed by the President, with Senate approval, and the term of office of each member of the commission would be staggered. The term of tenure in office would be six years on a full-time salaried

basis. The group would "administer, supervise and coordinate all civilian medicine."

In the New York Times we read the following:

"The first immediate objective of the commission would be the provision of medical care to the returning servicemen. Seven other major objectives would be (1) determination of the number of doctors the nation needs; (2) distribution of doctors according to the needs of the population; (3) assuring the financial security of the medical personnel; (4) provision of medical care and attention to the masses of our people; (5) preventive medicine; (6) autonomy of medical schools and medical institutions generally; and (7) hospitalization."

Dr. Bernheim said that the main contributing cause of present-day, unequal distribution of medical care is the lack of a fixed plan for distribution of physicians. We quote from Dr. Bernheim's address:

"To bring order out of chaos," he said "the medical profession must devise a plan for distributing its personnel. Before this can be done the doctor needs of the nation must be determined, while at the same time some scheme for giving financial support to medical students and doctors going into practice must be devised. . . . When 20,000 or 30,000 young doctors of the armed forces, who never have had civilian prac-

tice, return to civilian life a problem unique and loaded with dynamite will confront the medical profession and the nation.

"In danger of being socialized and not realizing it, the medical profession had best cooperate with the Government, collaborate and be more reasonable. With the masses demanding medical care at a price they can afford if organized medicine can find a better or surer way than compulsory health insurance to secure the required money, well and good, but failing that it must agree to it and quit stalling.

"Being financed by the Government from the day they start studying medicine until they are able to support themselves by taking positions with industrial concerns or medical institutions, joining a group or practicing alone, doctors will at long last be freed from that old dreaded wasteful period of waiting for patients, and society will get the services it needs. Licensure will become obsolete, his medical degree entitling a man to practice anywhere in the United States.

"A wise profession will control its own destinies by collaborating and cooperating with the Federal Medical Commission; it will decide who will study medicine, have control of medical schools, hospitals and laboratories, but it must guarantee that its personnel will be out there where they belong—even if at times and for certain purposes United States Public Health Service doctors must be called in."

This is a fragmentary outline of this, another, proposed plan. Maybe it has merit; maybe it is another impractical visionary scheme full of flaws. We are in no position to offer an opinion. But several thoughts keep going through our brain: Why cannot the States look after and control their special medical problems? Should the "backward" States be unable financially to put in effect a worth while, full-scale, medical-care program could not a legal means be found to seek and receive federal aid? In communities lacking medical personnel cannot the State advertise and offer attractive rewards for physicians to settle in these communities and practice? The cost involved would be widely different in different locations; a community in Mississippi would not call for the same overhead as a community in rural New York or Illinois. Could not the Public Health take over these far-away, poor, neglected places and provide physicians? It might look attractive to many of the present day, three-year graduates with a nine months' internship when the war is over and they are returned to civilian life.

The world is in a turmoil; positive opinions of today go out of the window tomorrow. After all would it not be good sense to let things remain in status quo until the war is over, until the "boys" have come back, and the master minds are fiddling with the future peace of the world?

T. S. W.



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# Original Articles

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## RESUSCITATION OF THE HEART\*

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AND

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IN the everyday practice of surgery many problems confront the surgeon. Some are obviously difficult and challenge his ingenuity. Others are obscure in nature, equally difficult and offer a still greater challenge. Cases of acute cessation of the heart beat come under the latter category.

In the past twenty-five years the advances in surgery and associated sciences have been rapid and progressive. Because of this the well trained surgeon of today is fortified with a wide and varied knowledge which enables him to offer his patients untold advantages.

The risk of operation has been markedly lowered by the strict attention to details with respect to the preoperative care and study of the patient. The surgeon institutes any corrective measures that may be necessary and thus places the patient in the best possible condition for operation. As a result, the operative risk entailed is lowered to a minimum and in the words of the late Dr. Daniel F. Jones, "The patient is made safe for surgery and surgery safe for the patient."

Despite all these added precautions there are patients in whom sudden and complete cessation of circulation and respiration occurs either during the induction stage of anesthesia or at any time during the course of an operation. It is with this particular group of cases that this study is concerned.

There is nothing so disheartening to a surgeon as "to lose a patient" on the oper-

ating table during an uncomplicated and technically simple operation. The appalling fact is that so many of these catastrophes occur among patients of previous sound health.

We know of no surgical emergency which outranks cardiac arrest and yet its treatment is grossly inadequate. Why the latter should exist in the light of present knowledge is difficult to understand. Bailey, Primrose, Norbury and Nicholson in England, and Bost and Beck in this country have been for many years strong proponents of immediate surgical attack in cases of acute stoppage of the heart. Despite repeated advice referable to having a preconceived plan of therapy if this emergency should arise, persistence in the use of ineffectual, conservative measures still obtains. This results in unnecessary delay. Thus, if surgery is done at all it is performed as a last resort and at a time when it has the least chance of success.

Boldness in execution and speed of action are mandatory. The early performance of cardiac massage is a *sine qua non* of success and should be our initial thought and not used as a last resort. This point cannot be stressed too strongly since the mortality will vary in direct proportion to the time interval between acute cardiac arrest and the beginning of proper treatment.

The purpose of this paper is to emphasize again those facts which will lead one to

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treat patients with acute cardiac standstill in a properly prescribed manner.

#### INDICATIONS FOR MASSAGE OF THE HEART

The evident reason why delay in performing cardiac massage is so prevalent is a lack of knowledge of the underlying indications for its performance. The prime indication for cardiac massage is acute cardiac arrest.

The question often arises, when has the heart stopped beating? A lack of the proper answer produces delay in treatment. For purposes of clarity we may classify cases of acute cardiac standstill into three groups: (1) simultaneous failure of respiration and circulation; (2) respiratory failure with subsequent arrest of heartbeat; (3) acute cardiac standstill with resulting secondary failure of the respirations.

In Group I, if an evident response to the usual methods of resuscitation does not occur within one minute manual massage of the heart should be performed and an adequate artificial respiration maintained. The peculiar appearance of the patient in which there is a complete cessation of the heart beat and respiration is pathognomonic. The staring expression, the relaxed jaws, the fixed pupils, the grayish pallor and mottling of the skin are all characteristic. It was this same picture, described by the earlier writers as "white asphyxia." When once seen its future recognition is not difficult. If present, there should be no delay in performing cardiac massage.

To determine definitely that the cessation of the heart beat is complete Primrose (1935) advocated the use of amyl nitrate. He stated that the ordinary "faint" recovers immediately with an artificial inhalation of the drug, whereas the arrested heart cannot respond.

In cases of the second group, cardiac standstill occurs during a variable period following the arrest of the respirations. In the frantic efforts to reestablish respirations the arrest of the heart is unrecognized. Following the establishment of a patent air

way and adequate respiratory exchange, the expected response does not occur. It is then that attention is focused upon the heart. Further delay in the performance of massage results from the administration of varied cardiac stimulants, the most popular being the intracardiac injection of epinephrine. It is in cases of this group that the anesthetist or surgeon, as the case may be, should appoint a competent assistant to the task of observing the competency of the circulation. When there appears clinical evidence of cessation of the heart beat this information should be immediately rendered, and preparations made for performing manual cardiac massage if the expected improvement does not ensue within a short period. This meets with the objection by many who state that the circulation is still adequately maintained despite the absence of the heart beat and a recordable blood pressure. The burden of proof rests heavily upon those who for this reason object to massage. It is here that massage of the heart, if performed at all, is performed too late.

In Group III we find the smallest number of cases. It is rare to have complete cessation of circulation and persistence of normal respirations since the latter fails either first or simultaneously with the circulation. However, if such does occur, the respirations cannot conceivably persist for more than a few seconds. This group should be benefitted by early massage since attention is directed primarily to the impairment of the circulation. It is the first sign of difficulty perceived by the anesthetist. The premonitory signs may be in the form of an increase in pulse rate or a cardiac arrhythmia. However, delay in massage occurs when time is consumed in the administration of cardiac stimulants. These drugs, in our experience do nothing more than sensitize an excitable heart with the resulting production of ventricular fibrillation and death.

Here again the importance of team work and prompt action is paramount. If cardiac massage is performed before irreparable

changes have occurred and if artificial respiration is maintained, a successful and complete recovery should occur.

#### ARTIFICIAL RESPIRATION

The establishment and the maintenance of a patent airway in conjunction with artificial respiration is the *sine qua none* of success in cardiac resuscitation. Massage of the heart alone is of no avail if proper exchange of the gases in the pulmonary alveoli cannot occur. The converse is also true, although it has been stated<sup>102</sup> that "proper pulmonary ventilation may prolong the period of possible resuscitation beyond the 5-8 minute limit and allow more time for the restoration of the cardiac activity." This statement receives no support in scientific fact. It is impossible to transport oxygen to the brain if the heart is at a standstill. Artificial respiration in the absence of the circulation is worthless.

The value of a mechanically controlled, automatized type of breathing in intrathoracic operations and in resuscitation has been well demonstrated by both Crafoord<sup>25</sup> and Mautz.<sup>78</sup> By this method rhythmic insufflation during the inspiratory phase and a free outflow during expiration is obtained. It produces a type of breathing which more closely simulates normal respiration than any other method, but still it has not received the general recognition which it deserves.

If a machine of this type is not available, rhythmic compression of the rebreathing bag of the anesthetic machine will prove efficacious. The older methods of Sylvester and Schaeffer are inferior to those described, but in their absence, one or the other, preferably the Schaeffer method, should be used.

In cases of resuscitation, a spontaneous cardiac rhythm is obtained prior to the establishment of normal respirations. The latter function may be delayed for ten to thirty minutes following the return of cardiac function. It is, therefore, important to continue artificial respirations as long as

the heart maintains its beat. Bohn<sup>11</sup> reported a case in which normal respiratory function was not obtained until two and one-half hours following the return of a spontaneous cardiac rhythm.

The delay in the return of respiratory function varies in direct proportion to the duration of cardiac arrest. If the latter persists until irreversible changes have been produced in the brain, normal spontaneous respirations will not be resumed. However, a pathologic respiratory variant may be produced and persist for a variable period dependent upon the degree of cerebral damage produced by the anoxia.

The respiratory apparatus is in reality a complex mechanism. Lumsden,<sup>71,72</sup> as a result of his experiments in cats, described three brain centers concerned with respiration: (1) pneumotaxic center, (2) apneustic center and (3) gasping center. The pneumotaxic center, located in the pons inhibits the activity of the apneustic center and produces normal breathing. The apneustic center when uncontrolled sends out impulses productive of prolonged inspirations. The gasping center is located in the lower part of the bulb, and, as its name implies, produces a gasping type of breathing.

In the respiratory tracings of animals dying from asphyxia, each of the above types of respiration may be demonstrated. The failure of the various centers occurs from above downward. The pneumotaxic center fails first, then the apneustic and finally the gasping center. Breathing which at first is regular becomes slow. This is followed by prolonged inspirations associated with gasping and finally gasping alone which maintains life for a short time. Recovery is in the reverse direction, i.e., gasping, prolonged inspiration, slow regular respirations and finally normal breathing.

This work of Lumsden has not been fully accepted by physiologists and further confirmation is necessary. However, it is of clinical interest to note that in one of the cases reported below (Case II), recovery of respiratory function proceeded as Lumsden described. In this case recovery was

incomplete in that the pneumotaxic center failed to recover.

It is most important to emphasize the interdependence of the circulatory and respiratory systems in the maintenance of life. Whichever system fails first is of no great concern. It is the early recognition of failure and the immediate institution of the appropriate corrective measures which is most important. Respiration and circulation are all too often thought of as individual entities instead of a vitally balanced unit, the appreciation of which is essential for successful resuscitation.

#### RESUSCITATION OF THE HEART

The period of resuscitation may be defined as the period following acute cardiac arrest during which time the normal rhythmical contractions of the heart may be restored and complete recovery ensue. Its duration has not been exactly determined. The earlier writings were indefinite on this particular point and as a result many and varied time intervals have been quoted, ranging from eight up to as long as fifteen minutes. However, it is the opinion of most present day writers that the period during which resuscitation may be completely successful is not in excess of five minutes and most probably between three and four. We are in complete agreement with this statement.

Carrel<sup>20</sup> differentiates between general and elemental death. The former is manifested by a complete stoppage of the circulation in which the organs are still living and could be completely revived if they were given back their normal physicochemical conditions by re-establishment of the circulation. When, however, protoplasmic degeneration and death of the tissues occur as a result of a prolonged interruption of the circulation, it is spoken of as elemental death. Immediately following the cessation of the heart beat the organism is placed in a position intermediary between general and elemental death. Nevertheless, as long as elemental death of the tissues has not occurred,

complete resuscitation is possible. It then follows that the length of time during which the heart beat may be inhibited with ultimate complete recovery is dependent upon the rate of development of elemental death.

The cells of the cerebral cortex are the most sensitive in the body and are the first to be affected by the interruption of the circulation with its resultant ischemia and anoxemia. The cells of the medulla oblongata, spinal cord and peripheral nerves, respectively, are next in order of frequency to be affected. The tissue cells of the heart, however, are more tolerant and can recover function following periods of cessation of the heart beat from twenty-four to thirty-six hours. Similarly, other tissues like the kidneys and liver may recover complete function following arrest of the circulation for fifteen to twenty minutes. Since a chain is as strong as its weakest link, it is important to know the length of time that the general circulation may be interrupted before permanent changes occur in the tissue cells of the cerebrum.

There have been many animal experiments performed to determine the exact length of time the central nervous system of the intact animal could withstand interruption of the blood flow without the production of permanent or irreversible changes. Sir Astley Cooper<sup>23</sup> (1836) in a series of animal (dog) experiments, performed bilateral ligation of the vertebral, subclavian and carotid arteries. He observed the resultant convulsions and rapid cessation of respiration. Subsequently similar experiments were performed by Magendie and Poiseuille<sup>74</sup> (1837), Pike and Stewart<sup>59</sup> and Hill and Mott.<sup>57</sup> Pike and Stewart concluded from their experiments that cerebral anemia of fifteen minutes' duration was incompatible with life. In their series of ninety-three experiments on cats only five survived following a period of cerebral anemia of seven minutes and only one after fifteen minutes.

From his clinical experience Trendelenburg<sup>104</sup> stated that any period over forty-five seconds was fatal and from his experi-

ments upon apes, he arrived at a similar conclusion.

A patient of Nyström's<sup>86</sup> made a complete recovery following occlusion of the aorta and pulmonary artery for one hundred and five seconds. O'Shaughnessy did not believe that permanent recovery could be guaranteed beyond a period of thirty seconds despite experiments to the contrary.

The experimental investigations of Ford<sup>40</sup> (1928) upon the effects of asphyxia on the brain of the cat demonstrated the fact that the animal could be resuscitated from three to five minutes after cessation of respiration. Beyond this period resuscitation was impossible.

Demarest and L'Hermitte<sup>29</sup> (1939) discussed at length the gross and microscopical findings in the brain resulting from asphyxia in a case in which death occurred two days following cardiac massage with incomplete recovery (five minute cessation).

Gildea and Cobb<sup>44</sup> (1930) pointed out the difficulties in the routine production of immediate and complete cessation of the circulation to the brain by the experimental methods in general use. This was due to the variations in the degree of collateral circulation to the brain following the ligation of all the principal vessels.

It remained, however, for Weinberger and Gibbon<sup>109</sup> (1940) to demonstrate by their ingenious method the exact period of ischemia and anoxia tolerated by the tissue cells of the brain. This method has completely overcome the uncontrollable factor of variations in collateral circulation previously mentioned. In an attempt to estimate the length of time that the central nervous system of an intact animal could withstand total interruption of the circulation without the production of permanent cell damage, these authors interrupted the circulation abruptly and completely by clamping the pulmonary artery. By observation of the retinal vessels they could determine the moment that the circulation returned to the cerebrum when the clamp on the pulmonary artery was released.

From their experiments they concluded: (1) arrest of the circulation for three minutes and ten seconds or less was tolerated without any obvious neurological disturbances; (2) permanent alterations in psychic behavior occurred in those animals in which the circulation was arrested for three minutes and twenty seconds or longer; (3) when the circulation was interrupted for eight minutes and forty-five seconds or longer life could not be restored for more than a few hours.

These experimental findings are in agreement with clinical experience: Complete recovery results if the circulation is restored within five minutes following arrest of the circulation. The difficulty, therefore, is not so much in starting the heart but doing so before the vital tissues of the higher brain centers have suffered irreparable damage. It is, therefore, of the utmost importance to restore an adequate supply of oxygenated blood to the cerebral centers before irreversible changes (elemental death) have been produced.

Cases reported in the literature in which there has been cessation of the circulation for prolonged periods with ultimate complete recovery create a great deal of interest. In the case cited by Mollison<sup>82</sup> the period of cardiac standstill was reported to be not less than thirteen or more than twenty-four minutes. His patient remained unconscious for seven days and showed signs of severe cerebral irritation for a period of fourteen days. Permanent recovery ultimately occurred.

Fuizy<sup>42</sup> reported a case of a seventy-year old man in which the heart beat was restored by the intracardiac injection of adrenalin thirty-five minutes after all heart action had ceased.

Hyman<sup>61</sup> reported two cases of cardiac standstill of eleven minutes and fourteen minutes, respectively, with recovery by the intracardiac injection of adrenalin in the first case and metrazol in the second. Kleinberg's patient recovered completely twenty minutes after cessation of the heart beat.



The only logical way to explain these successes after such prolonged intervals of time is on the basis that complete cessation of the heart beat had not occurred but was enfeebled to such a degree that it could not be detected by clinical methods. Just as long as a trickle of blood flows through the brain centers degeneration of tissue will not occur<sup>89,99</sup> and complete recovery is possible if the circulation be augmented by artificial means.

A point of the utmost importance is to define and understand what is meant by the period of cardiac arrest. If a basic understanding of this term does not exist the reporting of cases as successes beyond the generally accepted time limit in which successful resuscitation is possible, will of necessity occur. It may be defined as the time interval between the cessation of the heart beat and the performance of manual cardiac massage. It is not and should not be considered as the time interval between cessation of the heart beat and the restoration of a normal spontaneous cardiac rhythm. This is of paramount importance because the moment effectual manual massage is begun an artificial circulation is produced which adequately supplies the tissue needs of the body until a spontaneous heart beat and normal respirations are obtained.

In a recent paper reported by Adams and Hand,<sup>1</sup> the authors failed to take into consideration this particular point. In a review of the protocol it was noted that the heart was seen to stop beating during the course of an intrathoracic operation. Manual massage of the heart was begun immediately in conjunction with the maintenance of artificial respiration by strong rhythmic compression of the rebreathing bag with only oxygen flowing. Massage of the heart was continued for twenty minutes, subsequent to which spontaneous rhythmic contractions occurred. This was soon followed by the return of a spontaneous respiratory rhythm and an ultimate complete recovery. The authors concluded: "This case demonstrates that the time

interval of cardiac arrest compatible with normal recovery is much longer than was formerly appreciated." We are opposed to this viewpoint. In fact we are of the opinion that the time interval of cardiac arrest compatible with normal recovery is less, if anything, than was formerly believed. In reality the period of cardiac arrest in the particular case quoted, did not exceed thirty seconds, since the heart beat was seen to weaken and then stop completely, following which massage of the heart was begun immediately. A competent artificial circulation was thus produced and at the same time proper oxygenation of the blood was obtained by the maintenance of artificial respiration. Therefore, normal conditions were simulated, which maintained the metabolic tissue needs of the vital centers until a spontaneous cardiac rhythm and respirations were resumed.

This case is of particular value in that it adequately demonstrates the importance of maintenance of both artificial circulation and respiration in the prevention of degenerative changes in the delicate nerve cells of the higher brain centers.

#### TREATMENT

*Cardiocentesis.* The use of this method is of historic interest but has no place in the present day therapy of cardiac arrest. The successes reported were attributed to the relief of the distended organ and to mechanical stimulation by the needle or trocar.

*Cardiac Stimulants.* Stimulation of the heart by the intracardiac injection of drugs, particularly epinephrine, is one of the most popular methods employed in cardiac resuscitation. However, despite the successes reported, it possesses certain disadvantages which may produce much harm if injudiciously used.

Epinephrine (adrenalin) is a valuable cardiac stimulant if administered when the proper indication exists. Conversely, it may produce much harm if used without discretion.

We have particular reference to the intracardiac injection of epinephrine. This mode of administration of the drug is too frequently used. It is given in such a routine manner that no possible forethought could be given to the indications and contraindications for its use. The danger in the indiscriminate use of epinephrine as a stimulant in acute cardiac standstill has been stressed repeatedly.<sup>33, 34, 35, 35, 90, 91, 109, 110</sup>

The failing heart is an irritable and excitable heart. The stimulation produced by the administration of the drug may be the factor in the production of ventricular fibrillation and death.

The efficiency of the drug in resuscitation of the stopped heart is of doubtful value. Primrose stated,<sup>91</sup> "Adrenalin is of little use in restoring the heart beat. It cannot initiate pulsations although it may produce ventricular spasm." In the experience of Bailey:<sup>4</sup> "Not once in 40 instances has an injection of adrenalin into the heart caused it to restart beating." One editorial stated,<sup>33</sup> "If the patient revives after such an intracardiac injection he would have revived without it." It is the opinion of Henderson<sup>35</sup> that; "One puncture will certainly not start an asystolic heart to beating again." Wiggers<sup>110</sup> advises that intracardiac adrenalin should be used with a great deal of caution if ventricular fibrillation is to be avoided following acute cardiac dilatation.

The experimental investigations of Danielopolu and Marcou,<sup>27</sup> on the exposed heart of the dog, demonstrated conclusively the inefficiency of the intracardiac injection of epinephrine in initiating cardiac contractions once complete cessation of the heart beat had occurred. In those experiments in which there was marked enfeeblement of the heart beat without standstill, increase in the force of contractions was obtained with epinephrine. The same authors concluded that epinephrine was amphomimetic in action. The sympathomimetic action predominates in the normal heart, but in cardiac syncope, parasympathomimetic predominance occurs which inhibits the heart. This latter

effect was overcome by the use of atropine prior to the intracardiac injection of epinephrine. The atropine renders the action of the epinephrine solely sympathetic.

Despite these views to the contrary the use of epinephrine in cardiac resuscitation has received ample support. It was the opinion of Fantus<sup>37</sup> that: "Intracardiac injection is the simplest and most certain method to cause the motor of the circulatory apparatus to resume motion and to effect resuscitation." He further stated: "Quite as important is its harmlessness even when injected into the heart muscle itself." These statements are not supported by clinical and experimental observations.

Vogt<sup>106</sup> favored the use of epinephrine by intracardiac injection. He reported fifteen cases with full recoveries in which there had been respiratory standstill for five minutes. In Bodon's<sup>12</sup> series there were twenty-three permanent successes in ninety cases. Guthman, Fraenzel and Vogt (1921) obtained twenty complete recoveries in sixty-six cases. Similarly, Raesche, Meyer, Petseloki, Goupuy, Meriel, O'Donovan and Seelheim reported favorable results with the use of this procedure. In a review of the literature Hyman<sup>61</sup> reported complete recoveries following acute cardiac standstill in 25 per cent of the cases in which the intracardiac injection of epinephrine was performed. To obviate the danger of producing ventricular fibrillation, he advocated the selection of the right auricle as the site of injection. If auricular fibrillation should occur, it would not be incompatible with life and would be amenable to therapy.

Epinephrine has not been the only drug which has been used. Bianchetti,<sup>14</sup> using caffeine, reported a complete recovery in a case in which cardiac standstill had been present for twelve minutes. Wieschowski also reported good results with caffeine. Immerman utilized 10 per cent glucose. Ronzini employed a mixture containing lobeline, atropine, adrenalin and pituitary extract. Others with equal success used

camphor, coramine, metrazol, strychnine and hypertonic solutions.

The good results reported with the use of so many and varied medications, leads one to believe that recovery was coincidental and not dependent upon the particular drug administered. The mechanical stimulus produced by the point of the needle has been claimed for the particular successes reported. This conception is not new. For several centuries the orientals employed stimulation of the myocardium by a needle point in cases of syncope or apparent death.

In review of the data accumulated and our own experience, it is our opinion that the intracardiac injection of epinephrine is of no value in restoring the heart beat once complete standstill has occurred. If it is used in a failing and enfeebled heart, ventricular fibrillation is most likely to ensue. Epinephrine should be used as a supplementary aid to massage in resuscitation of the heart. It is a drug which possesses definite therapeutic value, but its indiscriminate use as a stimulant in acute cardiac standstill is condemned.

A consideration of the utmost importance pertains to the use of epinephrine in conjunction with certain of the anesthetic agents.

Levy<sup>65</sup> demonstrated that chloroform sensitized the heart of the cat to epinephrine with production of ventricular tachycardia and fibrillation following its administration.

Meek, Hathway and Orth<sup>60</sup> compared the effects of ether, chloroform and cyclopropane upon the cardiac automaticity. They concluded from their experiments on dogs that cyclopropane rendered the ventricular automatic tissue more susceptible to epinephrine than either chloroform or ether. The latter had the least sensitizing effect.

The action of chloroform differs from cyclopropane dependent upon the plane of anesthesia. Chloroform sensitizes the heart during light anesthesia, whereas cyclo-

propane has its sensitizing effect during deep anesthesia.

A point of particular importance referable to cyclopropane anesthesia is the protective action of procaine hydrochloride in the prevention of ventricular fibrillation. It has been shown<sup>18,76,80</sup> in dogs anesthetized with cyclopropane, that if procaine is administered prior to or simultaneously with epinephrine, the incidence of ventricular fibrillation is markedly diminished. This drug reduces the sensitivity of the cardiac muscle and concomitantly raises the threshold for stimuli capable of producing fibrillation.

The intracardiac injection of procaine is also efficient in the treatment of ventricular fibrillation. In one series of experiments reported<sup>18</sup> a restoration to normal rhythm occurred in 66 per cent of the animals so treated.

The sensitizing effect of cyclopropane upon the heart has been repeatedly confirmed. It is justifiable to conclude that the administration of epinephrine during the course of cyclopropane anesthesia is an extremely hazardous procedure.

Hyman<sup>63</sup> advocated the use of an artificial pacemaker to provide an electrical stimulus to the heart. The pacemaker consists of a needle through which electrical impulses are transmitted to the auricle at a regular and controllable rate. The stimulus provides a focus from which stimuli may pass through the heart over its normal pathways. He presented experimental and clinical data to justify its use. The method is ingenious and may have merit. However, further general experience with it will have to be obtained before an opinion may be expressed relative to its merit in cardiac resuscitation.

*Manual Massage of the Heart.* This is the method of choice in resuscitation of the heart. The chance for complete success depends on the interval of time between cessation of the heart beat and the commencement of massage. This is the main factor which determines success or failure.

Cardiac massage, to be successful, must of necessity be performed early.

The value of cardiac massage in the production of an artificial circulation has been adequately demonstrated by Gunn.<sup>51</sup> He injected a solution of a blue-green dye into the cavity of the right ventricle of an arrested heart. Manual massage of the heart was then performed and followed a few compressions the dye appeared first in the lungs and then in the carotid artery. Massage had, therefore, propelled the dye from the right ventricle through the lungs, the left side of the heart and into the systemic circulation.

This brings up a concept of fundamental importance which we again wish to stress. The duration of cardiac standstill is calculated, not from the time that the heart ceases to beat and the restoration of a spontaneous rhythm, but from the time of cessation of the heart beat and the institution of an artificial circulation by cardiac massage.

*Mode of Action of Heart Massage.* As described by D'Halluin, manual massage of the heart favors: (1) depletion of the heart chambers, distended with blood; (2) acts as a mechanical stimulus to the heart; (3) produces an artificial circulation capable of maintaining adequate nourishment until a normal spontaneous rhythm is resumed.

*Methods of Massage.* There are three methods of approach in the performance of cardiac massage: (1) Transperitoneal subdiaphragmatic; (2) transperitoneal transdiaphragmatic, and (3) transthoracic.

*Transperitoneal subdiaphragmatic:* This has been the method most frequently used and the one which claims the highest number of complete successes. It is the preferred method of the majority of writers on the subject.

Since many of the cases of acute cardiac standstill occur during the course of an intra-abdominal operation, subdiaphragmatic massage can be quickly and readily accomplished. This is a distinct advantage since the all important factor, time, is saved with the resulting increase in the

percentage of complete recoveries. The exact number of successes by this method cannot be calculated since it has no doubt been performed many times with success but the cases have not been reported.

There are certain disadvantages which this method possesses that deserve mention: (1) The apical portion only of the heart can be reached; the attempts at compression produce an incomplete emptying of the dilated heart chambers. (2) It is conducive to early fatigue of the operator. (3) There is a lack of direct visualization of the heart. (4) One is unable to apply drugs directly to the surface of the heart to reduce the sensitivity if the necessity should arise. (5) It is more traumatizing due to the greater force of compression necessitated. (6) There is a relative high incidence of failure, cases recovering following direct massage after the subdiaphragmatic method had failed.

*Transperitoneal transdiaphragmatic:* In this procedure an opening is made in the diaphragm through which the hand may be inserted directly into the pericardial sac or adjacent to it and massage performed. To avoid injury to the superior epigastric or musculophrenic artery and to facilitate closure, Bost<sup>15</sup> advocated the use of a transverse incision in the diaphragm close to the costal margin. Nicholson<sup>84</sup> made an opening only large enough to admit the thumb. The heart was then massaged between the thumb and the fingers, the latter being subdiaphragmatic. Each author reported instances in which they met with success following failure of the subdiaphragmatic method. Except that the massage is more complete, this method possesses the same disadvantages as the subdiaphragmatic method.

*Transthoracic method:* This was the method used by Niehaus in his unsuccessful attempt and Ingelsbrud in his successful resuscitation of the human heart. Its use in subsequent cases resulted in a high incidence of failure and was universally condemned. In review of the cases in which it was employed the condemnation was not

justifiable. The interval of time between cardiac arrest and massage of the heart was so prolonged as to preclude successful resuscitation by any method.

The early fear of producing a pneumothorax was an additional causal factor in its fall into disrepute. However, due to the recent advances made in our knowledge of the physiology and pathologic physiology of open wounds of the thorax, in anesthesiology and thoracic surgery, this fear is no longer tenable. This method of approach in our opinion is the one of choice. Its advantages outweigh any disadvantages which it might possess.

In the earlier reports the heart was exposed by elevating a rectangular pericardial flap. This was time consuming and presented certain technical difficulties. Exposure of the heart through a transverse incision in the third or fourth interspace is adequate and readily performed. The incision extends from the anterior surface or left border of the sternum, transversely to the left nipple or anterior axillary line. The incision is deepened through the underlying fascia and muscle layers and the corresponding intercostal space. The adjacent costal cartilages above and below are sectioned and the corresponding ribs widely retracted. Everything is now in readiness to begin cardiac massage. The production of a pneumothorax is avoided if possible, but it is of no undue consequence if it should occur.

*Technic of Massage.* A preconceived plan of therapy, so strongly advocated by Bailey,<sup>4</sup> is conducive to calmness and proper organization of the personnel referable to their individual duties. One person should be delegated time keeper, another to prepare medications, the anesthetist to supervise maintenance of artificial respiration, administration of parenteral fluids, etc., and an assistant to prepare the operative site. Undue delay in the preparation of the latter should be avoided.

Rhythmic manual massage of the heart is performed prior to the opening of the pericardial cavity. In this way no un-

necessary time is lost in the establishment of an artificial circulation to supply the immediate tissue needs of the body. Massage is continued for two to three minutes; the pericardium is then opened and direct massage of the heart performed.

The heart is cupped in the hand with the apex directed toward the base of the palm. The fingers are inserted posterior and the thumb anterior to the heart and rhythmical compression performed. The compression should be slow and regular (equaling approximately half the normal rate or about forty to fifty times per minute) and the relaxation abrupt. A slow rate of compression allows a more complete filling of the heart with an increase in the stroke and minute volume output. This results in an increased efficiency of the artificial circulation.

The massage of the heart should be interrupted at regular intervals to encourage a spontaneous rhythm, which continuous massage does not offer. It often happens that when the massage is interrupted, the contractions will gradually become weaker and if manual compression is not immediately begun arrest of the heart beat will occur. If this feature should recur more than once, the combined intramural and intraventricular injection of epinephrine or some other sympathomimetic drug will prove most efficacious in increasing the strength of contractions. Prior to its use, however, a necessary precaution must be taken. The failing heart is a highly sensitive organ. Five cc. of a 2 per cent novocaine solution should be injected into the cavity of the right auricle or ventricle and diffused through the heart by massage before the injection of epinephrine. The novocaine produces a diminution in the irritability of the heart and lessens the possibility of a complicating ventricular fibrillation. Atropine ( $\frac{1}{75}$  gr.) has also been used for the same reason.

Warm saline solution should be frequently applied to the surface of the heart. Heat produces cardiac acceleration, increases conductivity and shortens the

refractory period. Furthermore the solution prevents tissue dehydration.

Ventricular fibrillation is a formidable complication in resuscitation of the heart and demands immediate corrective measures to obviate a fatal outcome. Several modes of therapy have been described but there is no one method which is specific. One of the earliest methods used in the experimental animal was the injection of a solution of potassium chloride (1 per cent) into the carotid artery toward the heart so as to perfuse the coronary arteries. It has also been administered by intracardiac injection. The action of the potassium ions on the heart produced a complete and absolute standstill, the latter occurring in the diastole. An attempt was then made to restore normal rhythm by the injection of calcium chloride (1 per cent).

Massage alone has been used in combating fibrillation of the ventricles and has met with some success in animal experimentation.

The topical application of metycaine (10 per cent) and novocaine (5 per cent) to the surface of the fibrillating ventricles was first described and employed successfully by Mautz<sup>77</sup> and confirmed by Beck.<sup>8</sup> These authors reported repeated successes in dogs and its value is suggested by similar results in the human. Cocaine (4 per cent) also may be used. (Case 11.) The beneficial effects of these drugs results from the reduction in the irritability of the myocardium. This elevates the threshold of the heart to incoming stimuli so that the minimal stimulus which produces fibrillation is ineffective.

Finally, there is the method of electrical countershock. Prevost and Batelli<sup>90</sup> (1899) were the first to demonstrate the value of this procedure in arresting ventricular fibrillation in the experimental animal. The fibrillation was induced in the normal hearts by the passage of an electrical current of forty volts. A return to normal rhythm was effected by cardiac massage and the subsequent passage of an alter-

nating current of two hundred forty to four hundred eighty volts through the heart. The period of circulatory arrest was assumed to begin with the fibrillation and end with the beginning of massage.

The basis for the use of the increased voltage was to produce a stimulus strong enough so that a simultaneous contraction of all the cardiac muscle fibers occurred with momentary inhibition of heart action. Following the termination of the refractory period the heart would then be more susceptible to a normal rhythmic response.

This work was confirmed by Hooker.<sup>58,59</sup> In his animal experimentation he found the short electrical countershock the most effective. A current of 1.0 ampere applied for 0.1 second through an alternating current of sixty cycles is just as effective as when applied for five seconds. By this means he was able to establish repeatedly a normal cardiac rhythm in the same preparation if the fibrillation had not persisted beyond two minutes. If longer than this, a spontaneous recovery of effective beats did not occur and massage of the heart was necessary to restore cardiac rhythm. The longer the period of fibrillation the less the chances are of successful resuscitation.

Wiggers,<sup>110</sup> using the method described by Batelli, of massaging the heart before the application of the electrical countershock, was able to restore normal cardiac rhythm in forty of forty-seven dogs in which fibrillation of the ventricles had existed for five to seven minutes. The preliminary massage produces an artificial circulation through the coronary arteries and overcomes any existing ischemia of the cardiac fibers.

Beck and Mautz<sup>8</sup> reported similar successes and encouraged by the results obtained in the experimental animal, Beck<sup>7</sup> considered its application to the human. He was the first to employ this method in man and reported the first successful defibrillation of the human heart.

The technic employed in "shocking" the heart to overcome fibrillation is that advocated by Beck.<sup>7</sup> Manual massage of

the heart is performed first to overcome cardiac dilatation, increase the tone of the heart muscle, and restore the coronary circulation. Two padded silver electrodes (25 sq. cm.), well moistened in sterile saline solution are applied to the surface of the heart, one anterior, the other posterior. An electrical current of one to one and one-half amperes, through a sixty cycle alternating current is applied for a fraction of a second (0.1–0.5 seconds). As a result the heart muscle is uniformly contracted and brought to a complete standstill. Upon relaxation a normal rhythm may be resumed. However, if fibrillation persists the procedure should be repeated.

Prior to the application of the second "shock" manual massage should again be performed and 5 cc. of a 2 per cent procaine hydrochloride solution injected into the cavity of the right ventricle to reduce the tone and irritability of the heart. If the restoration of a normal rhythm is not obtained and the heart remains atonic, 1 cc. of epinephrine or 5 cc. of 1 per cent calcium chloride is injected (intramural) into the right ventricle, to increase its tone and contractility. The previous desensitization of the heart by the injection of procaine hydrochloride greatly diminishes the likelihood of ventricular fibrillation occurring. The "shock" is repeated and the fibrillation is usually overcome. If it persists, this procedure may have to be performed several times to obtain the desired result.

Despite the excellent experimental results obtained in defibrillation of the heart by means of electrical countershock, too little attention has been focused on its application in man. Indeed a more general consideration of its merit should be engendered. To this end, a set of sterile electrodes should be available in the operating room for immediate use when the emergency arises.

CASE 1. W. A., a male Negro, age forty-eight years, was admitted to the Long Island College, Surgical Service, Kings County Hos-

pital, August 14, 1940, with a diagnosis of human bite infection of the middle finger of the left hand with abscess formation. On August 14, 1940, incision and drainage of abscess of finger were performed. At 7:20 P.M. cyclopropane anesthesia was started. The induction was unduly difficult and the patient offered strong resistance. At 7:25 P.M. open drop ether was substituted for the cyclopropane but anesthetic difficulties persisted. Incision and drainage of abscess were performed at 7:35 P.M. At 7:55 P.M. cessation of respirations and circulation occurred. Artificial respiration (Schaeffer) was immediately begun and oxygen administered. Caffeine sodiobenzoate (2 cc.) and epinephrine hydrochloride administered intramuscularly at 8:00 P.M. At 8:01 P.M. an intracardiac injection of epinephrine (1 cc.) was given with no response. At 8:05 P.M. pericardiotomy was performed. A transverse incision was made in the third interspace, left, with sectioning of the third costal cartilage and the pericardium opened. At 8:12 P.M. manual massage of the heart was performed by slow, rhythmic compression (fifty per minute) for a three-minute period. The heart continued to maintain a spontaneous rhythm for a subsequent three minutes, but the pulsations gradually diminished in force, necessitating further massage. Artificial respiration was maintained. At 8:15 P.M. epinephrine (1 cc.) was injected into the left ventricle; 0.5 cc. intramural and 0.5 cc. into the ventricular cavity, followed by manual massage. The rate and force of the heart beat increased perceptibly but ventricular fibrillation rapidly supervened. At 8:20 P.M. novocaine (2 cc.), 1 per cent solution, was injected into the right auricle and massage continued. At 8:23 P.M. an intracardiac injection of epinephrine (0.5 cc.) was given and massage continued. Ventricular fibrillation persisted until complete cessation of the heart beat occurred at 8:30 P.M.

Necropsy report showed that the heart weighed 400 Gm. The right ventricle was 0.4 cm. in diameter; the left ventricle was 1.5 cm. in diameter. The coronary arteries were patent and the walls were thickened and sclerotic.

Anatomical Diagnosis: (1) Human bite infection, middle finger, left hand; (2) dilatation of heart; (3) pulmonary edema, acute; (4) generalized arteriosclerosis.

Cause of Death: Cardiac dilatation and acute pulmonary edema.



*Comment.* This case is of interest in that following the failure of the usual conservative methods of resuscitation, restoration of cardiac rhythm was obtained by manual massage of the heart. This occurred despite the prolonged interval (seventeen minutes) between standstill of the heart and massage.

The heart prior to massage was motionless, dilated and possessed a flabby consistency on palpation. The danger in the indiscriminate administration of epinephrine was demonstrated by the immediate onset of ventricular fibrillation following upon its injection into the heart.

In review of this case certain changes in the outline of treatment may be recommended: (1) Massage of the heart should have been performed before the pericardium was opened. (2) Novocaine solution should have been injected prior to the administration of epinephrine, to desensitize the heart. This assumes particular importance when cyclopropane anesthesia is used. The use of a 2 per cent solution (5 cc.) of procaine combined with the topical application of a 5 per cent solution, would have been more satisfactory in the treatment of the fibrillation. (3) Massage of the heart should have been performed earlier. The main factor productive of failure in this case was the prolonged interval (seventeen minutes) between cardiac standstill and massage. If it has been decided that cessation of circulation and respiration has occurred, the immediate performance of cardiac massage is mandatory if complete recovery is to ensue. It is only in this way that our percentages of complete successes may be increased.

CASE II. This case is reported in detail because of the interesting diagnostic problem which it presented.

J. S., a male Negro, age fifty-nine, was admitted to the Long Island College, Surgical Service, Kings County Hospital, on May 7, 1942. The chief complaint upon admission was epigastric and low back pain. The only significant finding in his past history was that he had a thyroidectomy performed in 1937. Subse-

quent to that he developed persistent weakness and nervousness.

The present illness dated back two years (1940), when he noted a sense of fullness in the epigastrium and occasional attacks of pain. Anorexia and constipation were associated symptoms. There was no nausea or vomiting. At approximately the same time he noted a painless lump in the left side of his neck in the outer portion of the thyroidectomy scar.

One year prior to hospitalization a small painless mass appeared in the epigastrium. It increased gradually in size and upon admission occupied the whole of the epigastrium. Four months prior to hospitalization he developed epigastric pain with radiation along the left costal margin to the back. The pain was aggravated by the ingestion of food. Periodic attacks of dizziness, weakness and free perspiration were present for one month prior to admission. A weight loss of twelve pounds occurred during the course of his present illness.

Physical examination revealed the patient to be a well developed, well nourished ambulatory colored male, not appearing acutely or chronically ill. The positive finds were related to the cervical and abdominal regions; blood pressure 138/88, pulse 80, respirations 18, temperature 100°F.

A well healed lower "collar" incision was present in the neck. On the lateral third of the scar on the left side, a hard, non-tender, fixed mass 2 by 3 cm. in size was palpable. Two small firm nodes, each approximately 1 cm. in diameter, were palpable in the left anterior cervical chain.

In the epigastrium, extending slightly to the left, was a visible and readily palpable mass 15 cm. in diameter. It was smooth in outline. Downward movement of the mass occurred with inspiration. Palpation revealed it to be of a variable consistency; cystic in some areas, firm in others. No overlying tenderness or muscle spasm were present. In the left costo-vertebral angle, there was a definite fullness with overlying percussion tenderness.

Laboratory data were as follows: urine analysis: specific gravity 1020; albumen two plus; sugar negative; microscopic examination: negative. Similar findings were reported on repeated examination. Red blood cells 5,200,000; hemoglobin 16 Gm., white blood cells 5,600; polymorphonuclear neutrophile leuco-



cytes 64 per cent; lymphocytes 36 per cent. Blood chemistry; urea 25; creatinine 1.19; sugar 150.

X-rays were taken of the gastrointestinal area and the following reported: "No intrinsic lesion of the stomach or duodenum. There is a large mass displacing the stomach upward and anteriorly. The mass arises from the region of the retroperitoneal space on the left side. Conclusion: Retroperitoneal mass displacing the stomach." *Chest*: "No evidence of metastases. Moderate tortuosity and elongation of the aorta." *Retrograde Pyelograms*: "Retrograde filling of left kidney reveals no irregularity or dilatation of the calyces or pelvis on that side. There is slight elongation of the upper major calyx with tortuosity and elongation of the left ureter as a result of a ptosed position of the kidney. Conclusions: Retroperitoneal mass displacing the left kidney downward, arising from the upper pole of the kidney, the left adrenal or from the retroperitoneal structures themselves." *Peri-renal air Insufflation*: "Outlines all but the upper pole of a ptosed left kidney. The upper pole merges indistinguishably with a football sized soft tissue mass which extends approximately one inch from an elevated diaphragm (left) to a level one and one-half inches above the crest of the ilium. This mass produces displacement of the neighboring intestinal shadows but appears to be in the retroperitoneal space."

Following upon the completion of the various diagnostic studies the diagnosis of a pseudocyst of the pancreas was entertained and operation advised.

Operation was performed on June 16, 1942, at 9:30 A.M.: "Under satisfactory cyclopropane anesthesia, the peritoneal cavity was entered through an upper right rectus muscle splitting incision. A large mass presenting through the gastrocolic ligament, displaced the stomach upward and the transverse colon downward. The gastrocolic ligament was divided between clamps and the posterior parietal peritoneum overlying the mass was incised. A large, solid tumor mass appeared which was gray-white in color, irregularly nodular and firm to palpation. Many tortuous vessels coursed irregularly over its surface. It extended well to either side of the midline and was considered inoperable. A biopsy was obtained and the wound was closed with through and through sutures of heavy black silk. Further approximation of the skin

edges was obtained with interrupted sutures of fine black silk."

Throughout the course of the operation the condition of the patient was very satisfactory. The anesthetic (cyclopropane) was discontinued at 10:20 P.M., at which time the blood pressure was 140/80 and the pulse 88.

At 10:25 A.M. when the last skin suture was inserted the operator (J. L. M.) was informed that neither the blood pressure nor pulse could be obtained. There was no respiratory exchange. Immediate artificial respiration was performed by rhythmic compression of the rebreathing bag, using 100 per cent oxygen. At 10:30 A.M. a transverse incision was made into the third interspace on the left side. The third costal cartilage was sectioned and the pericardium exposed. At 10:34 A.M. manual massage of the heart was performed by slow rhythmic compression, (50 to 60 times per minute) for two minutes. Spontaneous but weak cardiac pulsations were obtained, which persisted for one minute. Manual massage was again performed. Two minutes later 5 cc. of 2 per cent procaine hydrochloride solution was injected into the right ventricular cavity. Massage was continued for another two minutes following which epinephrine ( $7\frac{1}{2}$  mx) was injected into the wall of the right ventricle. The tone and contractility of the heart increased immediately, but ventricular fibrillation rapidly intervened. Five cc. of cocaine solution (4 per cent) was applied to the surface of the fibrillating ventricles with a medicine dropper. Within two minutes a normal cardiac rhythm was established. Throughout this whole period, artificial respiration was maintained as originally described. A mixture of oxygen, 93 per cent; carbon dioxide, 7 per cent, was substituted for 100 per cent oxygen. At 11:00 A.M. the first spontaneous respiration occurred. Blood pressure was 180/90, and pulse 96. The cardiac pulsations were regular and strong. Warm saline solutions were applied intermittently to the surface of the heart. Artificial respiration was continued and blood transfusion, of 500 cc. was started. At 11:15 A.M. the respiratory rate was fourteen per minute. Respirations were sighing in character and prolonged. Artificial respiration was then discontinued and the cardiac rhythm was normal. The thoracic wound was closed in layers and the patient was transferred to the ward. At 11:30 A.M. the blood pressure was

190/90, pulse 96, respirations 14. Movements of the right arm and head were present. At 12:00 noon periodic and slight muscular twitching movements, more marked in the right side, were noted for the first time. Subsequently, mild decerebrate convulsive seizures occurred which increased progressively in frequency and severity. At 2:15 P.M. the respirations were of the Cheyne-Stokes variety and the pulse was very irregular. The decerebrate convulsive seizures became more severe and death occurred at 2:45 P.M., three hours subsequent to the restoration of the heart beat.

*Comment.* No medications were employed prior to massage of the heart. In particular the intracardiac injection of epinephrine was avoided until following desensitization of the heart. Despite this precaution ventricular fibrillation ensued shortly after the intramural injection of epinephrine. However, a normal rhythm occurred within two minutes following the topical application of 5 cc. of cocaine solution (4 per cent). The advantage of direct exposure of the heart in the treatment of a complicating ventricular fibrillation was adequately demonstrated.

Artificial respiration was begun immediately following the cessation of the normal respirations. The first spontaneous respiration did not occur until twenty-four minutes following the restoration of a spontaneous cardiac rhythm. The duration of respiratory inhibition bears a direct ratio to the interval of cardiac standstill. The importance of the maintenance of adequate artificial respirations in cardiac resuscitation is well illustrated.

The important point to be stressed in this case, as in the previous one, is the necessity of performing massage of the heart at the earliest moment possible. The exact timing of the events that transpired were carefully recorded by a time keeper. There was a delay of nine minutes between cardiac standstill and the performance of massage. This latter time interval exceeds the generally accepted period of three to five minutes during which complete recovery is possible. The success in this case was partial in that both spontaneous cardiac

pulsations and respirations were obtained. However, the anoxia was so prolonged that irreversible changes were produced in the brain cells, which prohibited a complete recovery.

It is most important that the decision to perform massage of the heart be made within the first minute and a pericardiotomy promptly performed. Delay, encouraged by the use of conservative measures and "hopeful waiting" should be avoided if, complete recovery is to be expected.

### CONCLUSIONS

1. Acute stoppage of the heart is a surgical emergency demanding immediate action if complete recovery is to be obtained. A preconceived plan of therapy avoids delay and confusion.

2. The percentage of complete recovery in resuscitation of the heart will vary in direct ratio to the time interval between cardiac stoppage and the production of an adequate circulation by massage.

3. The maintenance of a free and adequate artificial respiratory exchange during the course of resuscitation of the heart is essential.

4. The cases of cardiac stoppage, capable of complete resuscitation are those resulting from asphyxia, reflex vagal inhibition, cardiac trauma, cardiac toxins (drugs, anesthetics) acute cardiac dilatation, hemorrhage and vasomotor paralysis with resulting circulatory insufficiency, and electrocution.

5. The indiscriminate use of the intracardiac injection of epinephrine or other sympathomimetic drugs is condemned.

6. Sympathomimetic drugs should not be administered during the course of cyclopropane anesthesia.

7. Procaine hydrochloride (2 per cent) administered prior to or simultaneous with the intracardiac injection of epinephrine lessens the possibility of ventricular fibrillation occurring.

8. The topical application of procaine (5 per cent) (metycaine 10 per cent) or

cocaine (4 per cent) may also be used to the surface of the heart; the injection of the 2 per cent solution into the chambers of the heart and electrical countershock are the most efficiency methods in the treatment of ventricular fibrillation.

9. The transthoracic approach is the method of choice in the performance of cardiac massage. Exposure of the heart is obtained through a transverse incision in the left third or fourth interspace, the adjacent costal cartilages sectioned and the corresponding ribs widely retracted.

10. Manual massage of the heart is the most effective means of initiating cardiac contractions. If uniform success is to be obtained, massage must be performed within three minutes following cessation of the heart beat.

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# OSTEOPLASTIC PROCEDURE FOR CORRECTION OF FUNNEL CHEST

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THE usual objective of thoracoplastic operations is to *diminish* the size of the thorax in order to assure a permanent collapse of a definite portion of the lung. However, a thoracoplastic procedure to enlarge the thoracic cage is indicated when the areas occupied by the heart and great vessels are encroached upon by pathological processes or structures.

The first attempts in this direction were undertaken as palliative measures in cases of inoperable mediastinal tumors or very large aortic aneurysms. The sternum was split in two, (Milton<sup>1</sup>), and a wooden or metal wedge inserted between the segments (Sauerbruch<sup>2</sup>), thus enlarging the mediastinal space and relieving the superior vena cava and trachea of excess pressure. Certain deformities of the chest skeleton, the most common in practice being the congenital or traumatic depression of the lower parts of the sternum, "funnel chest," present a more complex surgical problem.

Operative correction for a pronounced condition of funnel-chest is indicated for the following reasons: (1) Non-surgical treatment offers no hope of cure. (2) The deformity causes displacement and twisting of the heart and abnormal pressure upon the right auricle and ventricle with resultant circulatory and nerve-impulse conduction disturbances. (3) The chest skeletal structure in these cases tends to become fixed at an early age, causing a harmful decrease in the potential respiratory excursions. This predisposes to asthma and emphysema and increases the hazard of pneumonia.

In their report to the French Orthopedic Congress in 1934 Ombrédanne,<sup>3</sup> Garnier<sup>4</sup> and Mathieu<sup>5</sup> presented a detailed discus-

sion of the anatomy, the various clinical features, and the therapeutic measures which had been applied. In 1939, A. Ochsner and M. de Bakey<sup>6</sup> published another review of the literature and gave a case report of a patient operated upon by them.

Garnier<sup>7</sup> describes the surgical advances in treatment as follows:

"The first operations, originated by L. Meyer,<sup>8</sup> consisted in small-scale decompressive chondrectomy. The next step was the resection operation involving the whole depressed sternochondral mass, done by Sauerbruch<sup>9</sup> and by Lexer.<sup>10\*</sup> Since 1931 more involved osteoplastic procedures have been introduced by Sauerbruch and Nissen<sup>11,12</sup> in Germany and in France by Ombrédanne, Garnier and Mathieu."

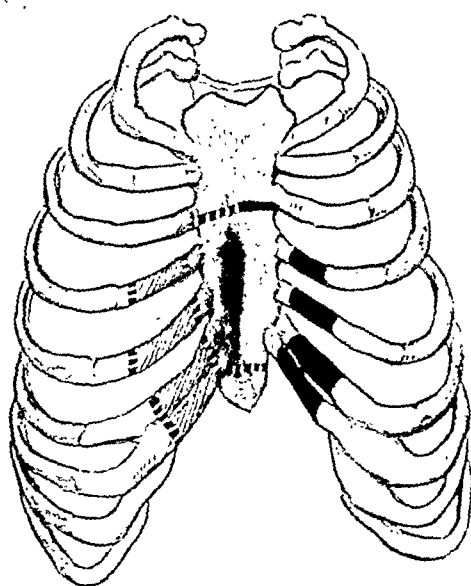
It should be added that in the United States, J. Alexander<sup>13</sup> in 1931 published another osteoplastic method, namely, dividing the deformed sternal segment by a T-shaped split. Any method which failed to alter the faulty anatomic position of the sternum could not be expected to effect a cure. Although division of the costal cartilages, as proposed by Meyer, would permit improved respiratory excursions, the harmful direct mechanical interference with cardiac action would not be relieved.

Complete excision of the deformed sternum and of the adjacent rib segments, first performed by Sauerbruch and Lexer, would decompress the heart, but would

\* Ochsner and DeBakey note that in Lexer's case "the sternum was turned around so that the anterior surface became posterior in order to protect the heart." According to the text of Hoffmeister's publication such a procedure may have been planned but was never performed. Lexer apparently realized full well the difficulty if not impossibility to reanchor in this way the transplant in the desired position.

leave the organ dangerously exposed to trauma and to the damaging effect of paradoxical respiratory excursions in the exposed area.

Bakey<sup>13</sup> obviated this by dissecting the depressed segment completely free from its mediastinal and tendonous attachments followed by extension for several weeks.



— I. STAGE  
 ■ II. STAGE

FIG. 1.

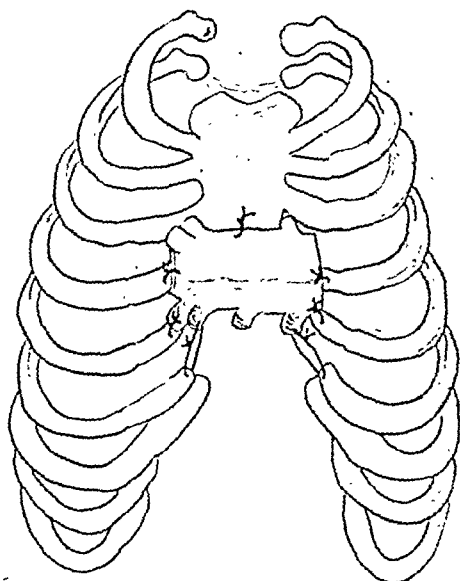


FIG. 2.

FIGS. 1 AND 2. Schematic drawings illustrating the two-stage resection and the final position of the transplant.

In our early operations we attempted to apply an extension mechanism to the sternal segment after its separation from the ribs, so as to anchor it in normal position; but it was found out in a subsequent case, that that was not enough, due to the lack of mobility of the sternum. J. Alexander was fully aware of this disadvantage, because he had already combined traction with the above mentioned T-shaped osteotomy in his early case. Ombrédanne achieved the same mobility by adding a transverse dissection. However, although the sternal segment had been freed from adjacent bone and cartilage its muscular, fibrous, and tendonous attachments to mediastinum, diaphragm and rectus sheaths often prevented permanent stability in the desired position. A. Ochsner and M. de

But none of all these methods establishes firm connection between the lifted sternum and the ribs. Therefore, the faulty position may be resumed later on. A firm, new junction of the lifted sternum and the stumps of the ribs is desirable.

These various considerations led us to plan certain modifications with a view to improving the operative and mechanical end result, as described in the following case history. It offers, incidentally, the advantage of dispensing with the complicated traction.

#### CASE REPORT

A twenty year old chemist complained of shortness of breath and precordial pressure. His father, one brother and one sister have a mild degree of funnel chest. Examination of

the father in 1937 revealed slight enlargement of the heart and changes in the electrocardiogram indicated mild myocardial damage. The

upward. The mediastinum, too, was shifted to the left, the vena cava not being visible, as is customary, on the right side. Due to the

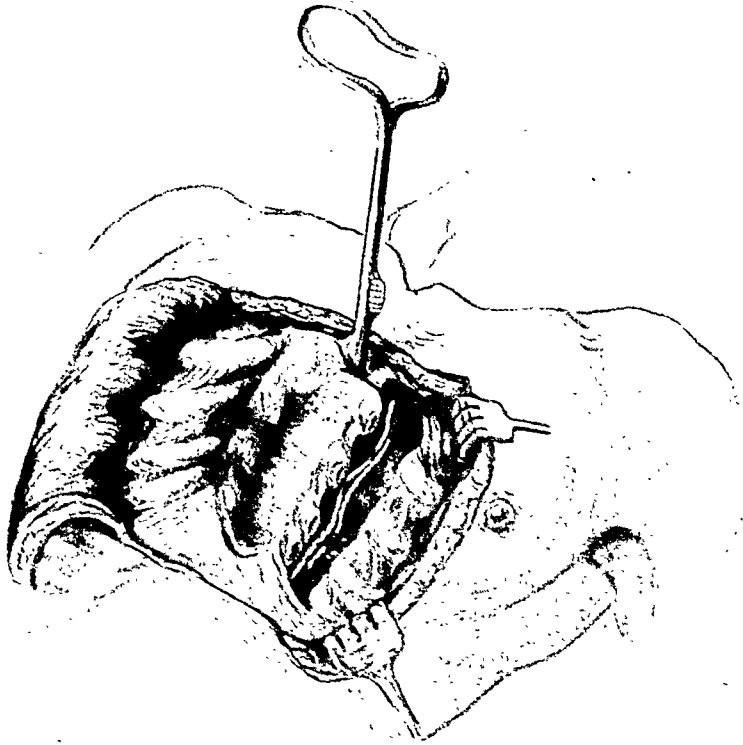


FIG. 3. First stage: Resection of the cartilaginous rib portions on the left side is done. A special chisel is driven half way across the sternum. The course of the internal mammary vessels is indicated.

patient's tonsils had been removed twice, otherwise he was never really sick and no other operation was ever performed.

He complained of shortness of breath, a feeling of pressure in the cardiac region, was easily fatigued and had difficulty in maintaining his weight. His appetite was satisfactory. He had a tendency toward bronchitis. Two cardiologists recommended corrective operation for the funnel chest. Dr. D. Scherf referred the patient to us.

Physical examination revealed the blood pressure to be 140/80; heart sounds were normal. The chest showed a very distinct malformation (funnel chest). The inner dimensions of the chest were above average, the width of the thorax being 32 cm., the depth of the thorax being 20 cm. at the site of the nipples and 14 cm. in the middle of the chest. The depression, therefore, at the middle of the chest was 6 cm. deep; respiratory range was 4 cm.

X-rays showed the heart to be of the bowl-shaped type shifted to the left and lifted

displacement of the heart to the left side, the right hilus shadow appeared more pronounced than under normal circumstances. The measurements of the heart were found to be normal. The apex of the heart was rotated toward the back so that the right ventricle was in contact with the left chest wall to a greater degree than usual. The lateral x-ray view showed also that the main mass of the heart was in contact with the left part of the chest wall next to the depression. The retrocardiac space was considerably narrowed. There were no additional important findings in pictures taken in the two oblique diameters. Pictures taken with empty and with filled stomach revealed the following: In the afternoon when the stomach was filled, the heart was shifted farther upward than in the morning; the bowl-shaped configuration was more pronounced, indicating that the right ventricle and not, as usual, the left ventricle, formed the left borderline. The electrocardiogram showed a widened s-wave in lead I, and a widened upward directed s-wave in leads II and III. Thus leads II and III



appeared to be splintered. T in lead III was inverted. The chest lead c R-5 showed a slightly widened s-wave. The question must remain



FIG. 4. Second stage: After complete dissection the depressed part of the sternum is fastened in such a way that the originally long diameter is now horizontal and the originally posterior surface points anteriorly. The transplant is sutured to the rib stumps and to the upper part of the sternum. The xiphoid process is left in place.

open whether the changes in the electrocardiogram were due to myocardial damage of the right ventricle or whether they were only the consequences of the cardiac rotation and the shift of the heart to the left and backward.

The blood count showed a hemoglobin of 109; red blood cells 5,200; white blood cells 6,200; polymorphonuclears 56, leucocytes 40, monocytes 3, eosinophiles 1; urea nitrogen 22.7; creatinine 2.1; uric acid 3.7; glucose 80; carbon dioxide combining power 55.7 volume per cent; basal metabolism rate minus 14.

After three months' observation, operation was decided upon. The first stage of the operation was performed on November 5, 1943, (intratracheal cyclopropane anesthesia). A rectangular skin flap was formed with the long side running parasternally, along the corpus sterni on the left with the two horizontal incisions ending at the opposite parasternal line. After reflecting the flap toward the right side, the third rib was exposed, stripped of its perichondrium, and resected laterally from the sternocostal junction for about one inch. The same procedure was performed on the fourth, fifth, sixth and seventh ribs. During the manipulation of the third costosternal junction the onset of auricular fibrillation was noted. The pulse rate was 120 to 140 per minute for about seven minutes. It was noticed that

immediately after severance of the ribs the sternum attained a much more normal position. With the resection of this side completed, it was also noticed that the heart quieted down and appeared freed from a mechanically embarrassing situation. In concluding this stage, the corpus sterni at its upper end was chiseled across as far as the midline (Figs. 1 and 3.) Closure of the wound was by muscle sutures, subcutaneous and skin sutures. The patient had an uneventful recovery.

The second stage of the operation was performed on November 19, 1943, (intratracheal cyclopropane anesthesia). The old incision was reopened. After reflecting of the skin flap, the attachments of the fourth, fifth, sixth and seventh ribs were severed parasternally in much the same way as was done previously on the opposite side. The sternum was then chiseled across at the level where it had been begun at the first stage. Contrary to expectations, the sternum could not be lifted freely after complete transverse section. This was due to the fact that the pericardium was densely adherent to the posterior surface of the sternum. These adhesions had to be separated by sharp dissection. The lower end of the sternum was cut across with the bone cutter, leaving the ensiform process in place. The main part of the corpus sterni measuring about two and one-half inches on the side and one and one-half inches across had thus become a free transplant. It was then rotated 90 degrees so that the long diameter lay horizontally and the short diameter vertically. Thus, the transplant rested on the rib stumps and could not slip back into its old position. It was fastened by silk stitches to the rib stumps. (Figs. 2 and 4.) At first there was a considerable space between the mediastinum and the posterior surface of the reimplanted segment of the sternum. Filling of that space by a free graft of fat tissue was considered, but the heart slowly moved closer to the sternum transplant and the idea of a graft was abandoned. The wound was closed with subcutaneous and skin sutures.

On the second day after the operation, there was a temperature rise to 101°F. with signs and symptoms of atelectasis of the right lower lobe. On the fifth day, the temperature returned to normal. Healing of the wound was uneventful. The patient left the hospital on the fourteenth postoperative day and his general condition was satisfactory. The sensa-

tion of compression in the cardiac region had disappeared. Respiratory range on March 4, 1944, had increased to 11 cm. X-ray picture

changes in the mechanics of respiratory function secondary to the parasternal section of the ribs proceed by gradual stages,



FIG. 5. A, preoperative x-ray showing the depressed sternum; B, same picture as in A with the sternum outlined.

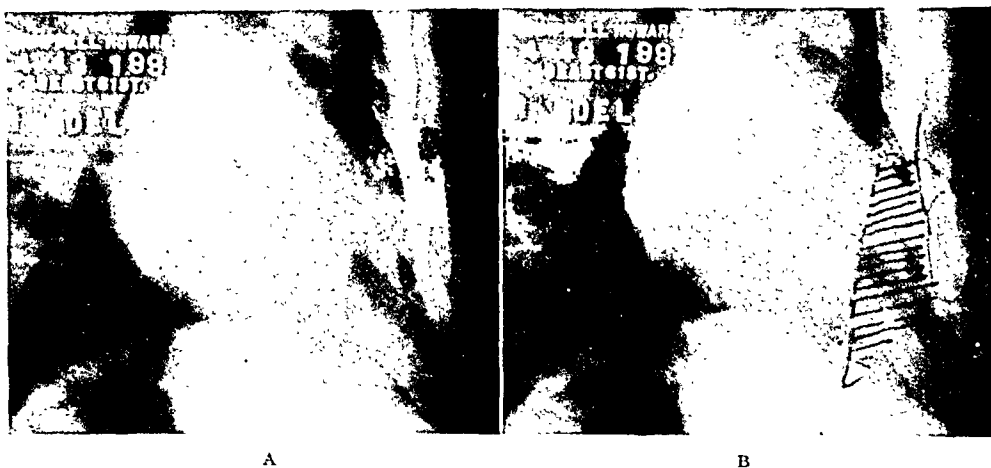


FIG. 6. A, postoperative x-ray showing the situation of the transplant; B, the same as in A with the sternum outlined; shaded area indicates the gain in precardial space.

taken on the twelfth postoperative day reveal the desired mechanical result of the operation. (Figs. 5 and 6.)

Various objections might be raised in a critical examination of the operative procedure described above. It may be argued that doing the operation in two stages is unnecessary. We believe, however, that the

and lungs and heart should be given adequate time to become adapted to the new conditions.

Moreover, there is the danger of injury to the pleura. This is admittedly very likely to happen even though all possible precautions are taken. The damage may be done without there being any manifest

evidence of it. The most important clinical sign, namely, the appearance of air bubbles in the wound, is not infallibly diagnostic of pleural injury, for the bubbles may arise from the mediastinum itself due to respiratory changes in pressure. Because recognition of the occurrence of this complication of pleural injury is often so difficult, there would be danger of overlooking bilateral wounding of the pleurae if the operation were done in one stage.

Another debatable point is the question of whether or not to remove the xiphoid. As this portion of the sternum has no attachments to the ribs and does not lie in the immediate vicinity of the heart, its presence has no bearing on the mechanics of the operative result. To excise it from its connections with the diaphragm and rectus sheaths would unnecessarily complicate and prolong the procedure.

The empty space which may exist between the heart and the transplant has been mentioned in the account of the operation. In our case the heart spontaneously moved over to fill this area. If this should not happen in other cases, it will be necessary to transplant a piece of fat tissue into the cavity, despite the obvious drawback of utilizing two free transplants, one of bone and one of fat, at one operation. But to leave the space open would invite the danger of infection in the blood or serum which would collect there.

Finally, it may be argued that if the operation is done in childhood, the resected sternal transplant will not grow proportionately to the rest of the chest skeleton. The opinions of various observers differ as to the growth-potential of free autotransplants of bone, but the majority hold that a moderate degree of growth does occur. Because of the position in which the sternal transplant has been fixed in our method, growth would proceed primarily

in the horizontal direction, and thus probably decrease the danger of a separation between transplant and ribs as the thorax enlarges.

We do not believe it advisable to undertake the operation in early childhood when the risk is much greater than later on. It would only be indicated in the early years if serious circulatory symptoms were to make an attempt at surgical relief imperative.

#### SUMMARY

A method for osteoplastic correction of funnel chest is presented which is believed to avoid the disadvantages of previously described operations. The pros and cons of the various steps in the procedure have been discussed.

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# SYPHILIS AND PREGNANCY

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IN 1905, Schaudinn, a protozoologist, looking through a microscope, saw the *Spirochæta pallida* and announced the etiology of syphilis. Two years later Wassermann, Neisser and Bruck developed the serological test, making the diagnosis possible. In 1910, Ehrlich stated that the infection could be cured with salvarsan.

Preventative medicine probably never has been favored with three such epoch-making researches as the three announced during those five years. Armed with these excellent weapons, much should have been accomplished but relatively little has been done in the prevention and treatment of syphilis in the pregnant woman. There would be no infected newborn babies if their mothers were free of syphilis.

Parran has stated that 60,000 babies are born in the United States every year with congenital syphilis. Our rate for congenital syphilis alone is twice as high per thousand of our population as is Denmark's rate for syphilis of all types. The incidence of syphilis in obstetrical clinics varies from 1 to over 30 per cent. There is wide variation in the incidence of the infection in clinics of the same city, depending upon the difference in the clinic clientele.

A complete physical examination often gives no indication that the pregnant woman has syphilis. A chancre, during gestation, has not been seen in our obstetrical clinic during the past nine years. An infective lesion of the vulva would probably be noted by the patient. The vagina is rarely involved due to the protection of the stratified squamous epithelium. The cervix is the most common location of the chancre. The Fallopian tubes are rarely involved and the ovary practically never.

Unfortunately, unlike gonorrhea, which

causes sterility, the syphilitic woman is as fertile as the nonluetic.

About eight days following fertilization, the ovum becomes implanted in the decidua. The corpus luteum develops and reaches its greatest growth at the third month. At this same time the placenta begins to function. The trophoblast is soon differentiated into an active layer of Langhans and a syncytium. In the middle of pregnancy, the Langhans' layer thins out and finally disappears, leaving a thin syncytium. Possibly, the two layers, which early are luxuriant and active, act as the barrier which prevents the spirochæta from invading the fetus before the fifth month. In only one case, Trincisse found the spirochæta in the Langhans' layer; however, in ten cases the organism was noted in the syncytium. Fetal infection after the fifth month is common. Pregnancies which terminate in the first trimester occur as frequently in the serological negative group as in women with a positive serology. It therefore is believed that spirochætal infection does not cause an early abortion. The organism has not been recovered from an early fetus.

The absence or mildness of syphilitic infection during pregnancy suggests the probability of a beneficial effect during gestation.

Brown and Pearce injected a testicular emulsion of *Spirochæta pallida* intradermally in eight pregnant rabbits, and into an equal control series of three normal females, two females in heat and three males. Definite lesions with marked adenitis were present in all the controls at the end of the third to the fourth week. Four of the eight pregnant females inoculated in the same way failed to show any evidence of infection. Three showed slight infiltration at

the site of inoculation with no lymphadenitis. The one successfully inoculated pregnant rabbit was in the middle of her pregnancy.

Likewise, in women, there is apparently a protective mechanism, and this is especially true in those women who have become pregnant since their infection.

White and Davis, in their study of cardiovascular syphilis noted male infection to be five times more common than in the female. Turner observed both cardiovascular and neurosyphilis to be over twice as frequent in male as in female patients. Moore noted a lower incidence of neurosyphilis in women who had become pregnant since infection than in those who had not. Solomon, studying pregnancy histories in 559 syphilitic women admitted to the Boston Psychopathic Hospital, found that 44 per cent of those with cerebrospinal syphilis had never been pregnant, and concluded that women with this lesion were either infected with a severe neurotrophic strain of organism which affected child bearing, or that women who had become pregnant received some protection against neurosyphilis. The Cooperative Clinic Group, reporting the results of treatment in 591 cases of latent syphilis in females, noted 42.4 per cent of 283 who were pregnant obtained a satisfactory result, while only 29.7 per cent of 303 nonpregnant women had a favorable outcome; 18.4 per cent of the former and 42.2 per cent of the latter were Wassermann fast.

#### DIAGNOSIS

In taking histories of syphilitic women, it is surprising how few are aware of their infection. To depend solely on the patient's observation of primary or secondary lesions would result in the failure to treat about 90 per cent. Since practically all are masked or in the latent stage, the diagnosis must be made by a routine serological test.

While there is no typical syphilitic obstetrical history, succeeding pregnancies

often tend to be carried nearer to term. Late abortions, premature or full term stillbirths should arouse suspicion and an effort made to determine the cause of fetal death. All syphilitic mothers do not transmit the infection to their children, even if untreated. The time element from maternal infection to the delivery of her child is important. The older the infection, the less virulent it is. There is, therefore, less chance of transmitting the spirochæta to the child in utero. If the baby is luetic, the mother also is luetic. The father may or may not have the infection. In this state until 1938, when premarital serological tests were made a prerequisite to marriage, both contracting parties could have been syphilitic, neither having necessarily infected the other. In our clinic, 50 per cent of the husbands of patients receiving prenatal syphilis therapy had neither a positive serology nor gave a history of treatment.

Unfortunately, too much emphasis has been placed on the so-called false positive of pregnancy. Following the development of the Wassermann test many conditions were thought to give a positive reaction. Among these were tuberculosis, malignancy, pregnancy, anesthesia, diabetes, scarlet fever and jaundice. However, as the technic of this test has improved, and trained serologists have become responsible for its interpretation, the incidence of false positive reactions has markedly decreased. Hinton did serological tests on 3,701 U. S. Naval aviation students. Only .56 per cent gave a positive reaction. However, of 862 inmates of The Massachusetts Reformatory for Women whom he studied, 40.49 per cent gave a positive reaction. Eagle tested the blood of 1,000 medical students, nurses and hospital employees, and only one was positive. An examination of this person revealed a chancre. A positive serological test performed by a competent serologist, especially if repeated, means syphilis.

Fordyce and Rosen believed that a Wassermann test done on blood taken just

before delivery is unreliable, and that a weakly positive reaction may occur in normal women during pregnancy. In this connection, 200 women having a negative blood serology in the prenatal clinics at the Kings County Hospital and The Long Island College Hospital were investigated. Blood was taken in the group during labor and tested by the Wassermann complement fixation technic, using two different cholesterolized antigens. At Kings County Hospital all reports were negative. A parallel group tested by two different flocculation tests, the Hinton and Kline, at The Long Island College Hospital likewise remained negative during labor.

That errors occur in serological investigations is admitted. Incorrect labelling of specimens, errors in typing reports, duplication of names and errors in laboratory technic may be mentioned. Then again, the serum may contain some unusual factor.

Some diseases, such as the following, may possibly give a false positive:

1. *Yaws*. This is an infection closely related to syphilis, caused by the *Spirochæta pertenuis*. It is non-venereal, although transmitted by contact, affecting chiefly children. It is limited to the tropics. Both complement fixation and flocculation tests will give a positive reaction. Morphologically, the *Spirochæta pertenuis* cannot be differentiated from *Spirochæta pallida*.

2. *Leprosy*. A positive serology has occurred in patients suffering from this malady. Investigators have reported marked variations in its incidence. Kolmer and Denny had no false positive reactions in 159 cases. Eagle states that duplicate samples of serum from fifty lepers tested by four modifications of the Wassermann technic and nine different flocculation tests gave from 40 to 76 per cent positive reactions. His series was selected as non-syphilitic.

3. *Malaria*. This disorder shows variations in the reports. In only one series the Wassermann or flocculation test was posi-

tive in about 30 per cent. Other reports show less than 1 per cent positive.

4. *Trypanosomiasis*. While this infection has been reported to give a false positive, more evidence is needed.

5. *Relapsing fever* in Europe caused by *treponema recurrentis*, described by Obermeir in 1868, occasionally gives a confusing reaction.

6. *Infectious Mononucleosis*. It has been noted in this disease that the serum contains an increased amount of heterophile antibody, and a false positive may be caused not by reagin but by an excess of amboceptor.

Before a diagnosis of syphilis is made, the test, if positive, should be repeated. A flocculation, as well as a complement fixation test is valuable. If doubt still exists, repeat in another laboratory. A positive complement fixation and flocculation test indicates that the serum contains reagin, which is a product of infection by the *Spirochæta pallida*. Eliminating the above mentioned possibilities of false positive reactions, a positive serum which has been confirmed is sufficient evidence for the diagnosis and treatment of syphilis.

#### PROVOCATIVE

Often one is confronted with a history which does not suggest syphilis yet the blood serology is weakly positive. To institute therapy unnecessarily is unwarranted. On the other hand, failure to protect a fetus in utero of a syphilitic woman is inexcusable. Today, a child has the right to be born without syphilis and may hold the physician responsible for neglect if the infection is not diagnosed and treated.

In doubtful cases of syphilis, we have used as a provocative injection 0.3 Gm. of neoarsphenamine in 10 cc. of freshly distilled water given intravenously. A serological test is done on blood taken one, four and eight days subsequently. If in the tests the reaction has increased from a low to a high one, treatment is indicated in the interest of the unborn child. The

following case may be mentioned as an example of the procedure:

A multipara had an admission serology of 1 plus. The test was repeated showing 2 plus. The provocative injection increased the reaction to 4 plus in the three specimens of blood taken one, four and eight days subsequently. Examination of her two children revealed a positive serology, as did that of her husband. The unborn child, in whose interest the test was performed, was, in the meanwhile, delivered. X-ray revealed positive leutic long bone changes. The entire family has syphilis and is now undergoing treatment.

It has been stated that, in the absence of syphilis, the injection of an arsenical would change a negative serology to a positive one. This has not been our experience. Recently, in the Prenatal Clinic of The Long Island College Hospital, we routinely gave this provocative injection to 400 pregnant women with negative Hinton and Kahn tests. Blood taken one, four and eight days after the provocative injection revealed that the Hinton and Kahn tests remained negative in each of the 400 patients.

While, probably, there is no false positive of pregnancy, there may be a false negative. McCord has autopsy material in which the organisms of syphilis were demonstrated in 221 abortions and babies of all periods of gestation. The Wassermann during pregnancy or in labor was negative in 29 per cent of these mothers. In 175 colored stillbirths in all periods of gestation, he noted syphilitic bone changes in thirty-seven babies, or 20 per cent. The maternal Wassermann was negative in sixteen, or 43 per cent.

Whether a husband can infect the fetus directly by *Spirochæta pallida* in the seminal fluid, while the mother escapes infection, has been discussed for two hundred years.

While an ovum in the Fallopian tube is approached by many spermatozoa, only one shall gain admittance. Where the male cell penetrates the ovum, the vitelline membrane loses continuity and the spiro-

chæta enters. As the walls of the membrane again close, it is so timed that the locomotive portion of the male cell is detached. The ovum is now impervious to all other cells. If the spirochæta were able to enter the ovum with the spermatozoan, its length, about three times that of the active factor of a spermatozoan, would probably be unable to enter completely, and the cytoplasm of the cell would be disturbed by its movements. Slight disturbances of cytoplasm tend to malformation and anomaly. It is infrequent that we find the latter in the syphilitic newborn.

Kemp analyzed his own cases and reviewed the literature of examinations of seminal fluid. Semen of individuals who knew when their infection was contracted was examined for the spirochæta by dark field examination, silver staining or animal inoculation. In sixty-seven individuals, the majority of whom had untreated florid secondary infection or mucocutaneous relapses, treponema were found in thirteen, or 19.4 per cent. However, in fifty-two individuals with late syphilis, only one case showed the spirochæta.

Body fluids, even blood, do not necessarily transmit the infection. Blood transfused into another from donors with a positive serology may or may not transfer the spirochæta. In one case in our clinic, syphilis was transmitted by a donor who had contracted the disease within the previous six months. In another case, an emergency transfusion of blood from the husband was given. The laboratory eventually reported his blood 4 plus, which remained the same on the repeated test. We have followed this recipient for years with many blood tests, and they have all remained consistently negative. The difference in these two cases is one of duration of the infection in the donor. It is not a question of positive serology, but whether, during the actual mechanical transfer of blood from donor to recipient, the fluid contains the spirochæta. McNamara knowingly transfused nine patients with blood of syphilitic donors. Five received blood

by one transfusion; three from two different donors, and one from three donors. In the follow-up of the recipients, neither serological nor clinical evidence of the infection was demonstrable.

#### TREATMENT

Treatment during pregnancy is directed primarily in the interest of the child in utero. Accordingly, the mother's syphilis is secondary. The limited amount of therapy during pregnancy will have but small effect on the maternal infection.

The fetus apparently is protected against invasion of the spirochæta during the first five months of gestation. McCord failed to find any organism in a dead syphilitic fetus weighing less than 100 Gm., the average weight at the fourth month. It was in the seventh, eighth and ninth-month fetus that the spirochæta was most often found.

Treatment instituted early is directed to *prevent* the infection reaching the fetus. Therapy begun late is intended to *treat* the infected fetus in utero. About 85 per cent of our cases are not seen until the latter half of pregnancy.

Snyder and Speert injected neoarsphenamine in rabbits and noted a progressive increase in the rate of placental transmission of arsenic to the fetus as the pregnancy approached term. After separating the maternal and fetal placental portions, they noted in the fetal part a total amount of arsenic six times as great as in the maternal portion. Within an hour following injection into a rabbit at term, a placental study revealed a larger amount of arsenic in the placenta than was transmitted to the fetus. Gradual liberation of arsenic from the placental reservoir to the fetus was revealed by the much higher content of arsenic in the fetus twenty-four hours following injection.

In four pregnant women receiving neoarsphenamine, Kraul and Bodnar noted arsenic in the three fetuses born in the latter part of pregnancy. In the fetus born at the sixth month, no arsenic was found. That arsenic or its derivatives pass the

placental barrier was observed by Eastman, who found a relatively large amount in the meconium and a relatively small amount in the blood of a newborn.

Too often, a patient seen late in pregnancy fails to receive treatment because it is believed that no benefit will result. It is never too late to treat, even though the chances are in favor of fetal infection. A relatively small amount of the arsenical given late in pregnancy is more efficacious than when given in the first five months.

From the obstetrical viewpoint it would be in the interest of the fetus in utero to assume the dictum that once a syphilitic mother, always a syphilitic mother. While it is true that those who have been well treated would probably deliver non-syphilitic children, it is apparent in taking histories on infected mothers that a large number have received inadequate treatment. Even if the Wassermann be negative, the patient may have a syphilitic child.

In spite of the extra load upon the emunctories, the pregnant syphilitic mother tolerates treatment well. By keeping alert for obstetrical complications and realizing the potentialities of the arsenicals, the dangers of therapy are slight. Blood pressure recordings and urinary analyses should precede each injection. If the patient is toxic, treatment should be withheld. Contraindications to treatment based on constitutional diseases play but a small part. Rarely have we seen a pregnant luetic woman unable to tolerate treatment.

Meta-aminoparahydroxyphenylarsine oxide or mapharsen, developed by Tatum and Cooper, is being used exclusively in the two clinics. Two hundredths of a Gm. of mapharsen dissolved in 10 cc. of freshly distilled water is injected intravenously in the basilic or cephalic vein. In a week, if the previous injection was well tolerated, .04 Gm. of mapharsen is given. The third week it is increased to .06 Gm., which is the maximum weekly dosage. We believe mapharsen injections could be given more often than each week, and if we encounter a recent infection, showing either chancre



or rash, we would not hesitate to do so. In our clinic 1 cc. of 10 per cent bismuth salicylate dissolved in olive or peanut oil is injected intramuscularly into the gluteal muscle. It was decided about five years ago to give *both* the intravenous and intramuscular on the same visit. This method has proved satisfactory. During pregnancy there are neither courses nor rest periods. The dual therapy is given weekly from the time of diagnosis to the delivery of the child. We are not concerned with too much, but too little treatment.

The injection of protoplasmic poisons is, however, an operation and cannot safely be performed on all pregnant women by everyone.

Previous to the recent interest in syphilis, the incidence of fatalities due to arsphenamine therapy was low—probably no higher than deaths resulting from chloroform poisoning. Meirowsky, secretary to an investigating committee, reported one death in 13,000 injections of old salvarsan, and one death in 162,800 injections of neosalvarsan.

As the chemistry and pharmacology of the drugs have improved, the fatalities have decreased. In the United States, the National Institute of Health, at Washington, determines the total arsenical content, toxicity in white rats, and the trypanocidal activity of each lot of drug, and directs that minimum standards be met before the preparation can be placed on the market. This should have a beneficial effect.

#### REACTIONS

While there are several types of reactions from the arsphenamines, three are of particular interest:

1. The nitritoid reactions are not uncommon and are primarily of a vasomotor origin. Soon after an injection of arsphenamine, the face flushes. There is a sensation of heat, dyspnea or palpitation. The patient appears anxious. The pulse is weak and there is a drop in blood pressure. She prefers to lie flat. These signs and

symptoms do not last long, and are relieved by adrenalin. Nausea and vomiting, particularly in those travelling by trolley car or subway, headache, dizziness and fever may occur and last several hours, forcing the patient to bed.

2. Arsenical dermatitis occurred in two of our cases previous to the use of mapharsen. Both women were colored. General itching is a warning to discontinue therapy, temporarily, at least. This lesion occurs early in treatment. In both cases, a generalized pyoderma was present. The eruption begins usually with a maculopapular or vesicular dermatitis, spreading over the entire body, face, trunk and extremities. In both cases, an intense edema was present. The patients appeared acutely ill. Exfoliation of the skin of the entire body occurs in about three weeks. Often an otitis media is present.

3. Hemorrhagic encephalitis occurs more frequently in pregnancy than in the non-pregnant woman. Cormia noted in forty-six women with this lesion that thirty-four were pregnant. It is a serious and often fatal complication following arsenical therapy. Ehrlich was familiar with this condition and believed it was not due to the drug but to some inherent weakness in the patient's blood vessels. It may also occur following an arsenical injection given intramuscularly. Since the damage is done early in treatment, usually under five and often following the second or third injection, it, apparently, is not an accumulation problem. The syndrome includes fever, headache, irritability, convulsions and coma. Death occurs in a day or two. The pathology is edema and multiple punctate or small ring-formed hemorrhages in the brain. Cormia reported a case in a pregnant woman in whom petechial brain hemorrhages were found not only in the mother but in the fetus as well. It is interesting that patients poisoned by inorganic arsenical compounds show large amounts of the drug in the brain but do not have an accompanying encephalitis.

## DIAGNOSIS OF SYPHILIS IN THE NEWBORN

Whether a child born of a luetic mother should be subjected to treatment or await signs or symptoms of the infection is often difficult to decide. The problem becomes simpler if the following methods are considered:

1. *Examination of the Placenta.* The value of diagnosis of syphilis from the placenta has lost much of its former importance. When a mother and child are syphilitic, one would expect a placental infection. However, placental lues is uncommon. McCord diagnosed only forty-eight syphilitic placentas from 1,085 strongly positive luetic women. The late J. Whitridge Williams diagnosed the infection in 12.1 per cent of infants who were eventually non-syphilitic, and failed to diagnose the placental lesion in 20 per cent of children who were congenital syphilitics. Warthin believed that the spirochæta was more numerous in placentas of macerated fetuses than in those of syphilitic living children. A review of charts of luetic and non-luetic patients delivered on the same day at The Long Island College Hospital suggests that the difference in relative weights of the placenta to that of the baby is not reliable to help in the diagnosis of syphilis. Today, a pathologist hesitates to commit himself definitely unless the spirochæta is found.

2. *The Cord Wassermann Is Not Reliable.* A child with a positive cord serology may eventually be free of syphilis, and a newborn with a negative cord serology may eventually develop evidence of the infection. The positive cord serology may be the reagin of the mother passing the placental filter and not the true serology of the child. The maternal and cord blood should be taken at the same time and titers of their reagin compared. A strongly positive maternal serology and a negative or weakly positive one in the cord blood should give a brighter outlook, as the arsenical seems to be more spirochæticidal in the fetal than in maternal tissue.

3. *Dark field examination of the scrapings*

*of the umbilical vein wall*, in a section taken near the placenta, offers promise. Ingraham found the spirochæta in nineteen out of twenty cases, but in sixteen syphilitic infants, the scrapings were negative. If the spirochæta is found, the diagnosis is proved. If, however, the organism is not seen, it should not be interpreted to mean that the child may not eventually develop the infection.

4. *Roentgen examination of the long bones* about the eighth day is probably the most reliable method of diagnosing congenital syphilis. Wegner described the pathology thirty-five years before Schaudinn discovered the spirochæta. McCord found osteochondritis in 51 per cent of 243 syphilitic fetuses at autopsy. McLean believed that the lesion is present practically always in congenital luetic children. X-ray diagnosis has been made of a syphilitic child in utero.

The pathology, an osteochondritis, takes place at the union of the epiphysis and diaphysis of the long bones—at Guérin's line. Normally, the line is straight and narrow, but in syphilis it is widened, wavy and opaque. Heavy metal deposits during prenatal treatment may confuse the picture.

5. *Pediatric Follow-up.* A child born of a syphilitic mother does best under the care of a pediatrician trained in syphilis therapy. The serology of the newborn is no more reliable than that of the cord. Repeated blood tests about four weeks following delivery should be done. If positive at this time, the child probably has the infection, and treatment is indicated. If negative, however, a repeated blood test is done every month for four months, and then every six months, until the child has reached the age of two.

## SUMMARY

1. The researches of Schaudinn, Wassermann and Ehrlich should have accomplished much in preventing and treating syphilis in the pregnant woman.

2. Physical examination often fails to suggest syphilis in pregnancy.

3. Alteration of the covering of the chorionic villi, which takes place in the middle of pregnancy, may be responsible for the loss of protection during late pregnancy.

4. Spirochaetal infection does not cause an early abortion.

5. Since syphilis, in practically all pregnant women, is masked or in the latent stage, the diagnosis must be made by a routine serological test.

6. Repeated late abortions, premature or full term stillbirths should arouse suspicion of syphilis.

7. Complement-fixation and flocculation tests should be done.

8. Provocative injection of 0.3 Gm. of arsphenamine may reactivate the reagin of the serum.

9. Injection of arsphenamine in non-syphilitic women does not cause a positive serology.

10. Spirochaetae have been found in abortions and babies of women whose serology was negative to the Wassermann test.

11. Blood transfused from a luetic donor does not necessarily transmit syphilis.

12. Treatment is instituted primarily in the interest of the child. The maternal syphilis is secondary.

13. Arsphenamine is found in the fetus late in pregnancy; the placenta serves as a reservoir.

14. It is in the interest of the child to treat the mother in each pregnancy.

15. Pregnant women are subject to encephalitis more often than non-pregnant women.

16. Examination of the placenta for syphilis has lost much of its importance.

17. The cord Wassermann is not reliable.

18. Dark field scrapings from the umbilical vein wall offers promise.

19. Roentgen examination of the long bones is very valuable.

20. Pediatric follow-up of children born of luetic women is imperative.

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# EPIDURAL INJECTION THERAPY FOR SCIATIC PAIN\*

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EPIDURAL injections have been used therapeutically for the past seven years in 116 cases. The conditions treated were sciatic neuropathy, sciatic neuritis, sciatic neuralgia, back pain, back injury with sciatic radiation, and lumbar and lumbosacral radiculopathy. (Table 1.) Relief of pain was the objective, although in a few cases soreness, painful numbness, muscle cramps, severe aching and burning were the main therapeutic indications.

TABLE 1

Diagnoses	No. of Cases
Neuropathy, sciatic, etiology undetermined....	63
Neuropathy, sciatic, traumatic.....	7
Neuropathy, sciatic, traumatic (back injury)...	8
Radiculopathy, lumbar and lumbosacral, etiology undetermined.....	7
Radiculopathy, lumbar and lumbosacral, traumatic (back injury).....	5
Neuralgia, sciatic, etiology undetermined.....	5
Neuralgia, sciatic, traumatic (back injury)....	8
Neuralgia, sciatic, psychogenic factor.....	4
Back pain.....	2
Neuritis, sciatic, infectious.....	7

The diagnosis of sciatic neuropathy or neuritis was made when the signs and symptoms were limited to that nerve distribution. The condition was designated as traumatic when verified trauma had occurred to the formed nerve at any point distal to its origin from the lumbosacral plexus. The diagnosis of neuritis was made only where there was a clear connection between the nerve involvement and an acute or chronic infection. The source might be an acute systemic infection, syphilis, obvious sinusitis, prostatitis or abscessed teeth. When symptoms were manifested in the sciatic distribution but no signs, the diagnosis of neuralgia was made. If back pain was present with or without previous back injury or with

signs and/or symptoms in the sciatic distribution, the requisite diagnosis was made as defined above.

When the signs and symptoms were manifested in a radicular distribution the diagnosis of radiculopathy was made with the cause of the disorder added when known. There were no cases of radiculalgia or radiculitis in this series.

If the psychogenic factor was outstanding and no other cause was found for the disorder, it was so listed. Even though not indicated in the tabulation, the psychogenic factor was prominent in a number of the other cases treated by epidural therapy or other means.

In view of the above definitions it becomes clear why the preponderance of cases were diagnosed as sciatic neuropathy of undetermined etiology.

The technic of the treatment was carried out in the following manner: The patient is placed face down on a stretcher, which is maintained in fixed position. A pillow is placed under the hips to elevate the pelvis. (Fig. 1.) The procedure can be carried out two to three hours after a meal and usually without sedative preparation. In about 5 per cent of cases sedative preparation was necessary because of the patient's apprehension and excessive reaction to pain.

The area sterilized extends from just above the rectum to about six inches above the sacral hiatus and six inches to either side of the midline. The skin is antiseptically prepared by one application of tincture of iodine, immediately removed with 70 per cent alcohol. Draining of the iodine or alcohol down about the rectum or scrotum must be prevented. In six cases

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in which the iodine was not immediately removed, severe iodine burns occurred. Four of these patients had other skin

short beveled No. 22 gauge two-inch needle. The fluid injected into the sacral canal is introduced through a short beveled



FIG. 1. Inserts A and B illustrate correct technic of inserting needle into caudal canal. Needle in caudal canal indicated by c. Correct position of patient, face downward and hips elevated is shown. (Illustrations courtesy of Dr. Geo. P. Pitkin from "Conduction Anesthesia," in preparation.)

idiosyncrasies. Antiseptics may be varied according to individual preferences.

The sacral hiatus can be located by palpation with the index finger or thumb upward from the tip of the coccyx and downward over the midline of the sacrum. The hiatus is identified when the palpating finger rests in a depression in which it can be rocked between two bony prominences, the sacral cornua. Usually it is present one and one-half to two inches above the coccygeal tip. However, anomalies are common. Often there are several dorsal apertures in the sacrum which may be entered for satisfactory further passage of the needle into the caudal canal.

The skin over the hiatus is infiltrated with  $\frac{3}{4}$  per cent metycaine through a short beveled No. 23 gauge one-inch hypodermic needle. The subcutaneous tissues and the sacral canal are infiltrated with 5 cc. of  $\frac{3}{4}$  per cent metycaine solution through a

No. 20 gauge three and one-half-inch needle with a metal bead security stop. Only in one instance was the needle broken. That time the break was proximal to the bead, which afforded a purchase for withdrawing the needle.

In the last five cases, half the epidural injections in each case were done without preliminary anesthetization of the skin, subcutaneous tissues and caudal canal. The three and one-half-inch No. 20 gauge injection needle with metal bead security stop was immediately inserted into the caudal canal.

These patients stated that the procedure was no more painful when the preliminary anesthetization was dispensed with. If patients continue to report no preference, this latter technic will be adopted.

From the viewpoint of the experienced operator this technic has distinct advantages. Skin and subcutaneous tissue

infiltration more or less obliterate the landmarks and make the procedure more difficult.

tip syringe. All the above syringes have been used at one time or another and given up for our present choice. They are

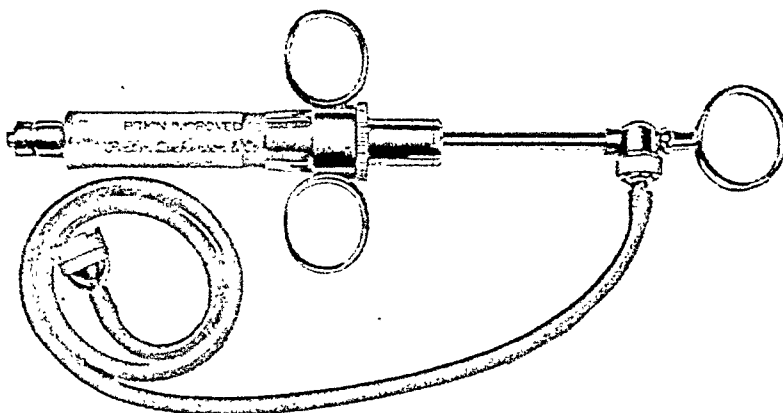


FIG. 2. Sana-Lok Pitkin improved 5 cc. continuous flow syringe with side tubing attached and weighted filter.

The preferred injection apparatus is the Sana-Lok Pitkin Improved 5 cc. syringe (B.D.P<sub>5</sub>SLI). (Fig. 2.) It has a glass barrel and a metal plunger which contains a spring return permitting long continued filling and emptying without having to remove the needle from the skin or disengaging the needle from the syringe. The spring return and rings for the fingers and thumb shorten the time of injection and prevent operator fatigue. The flow is controlled by a positive action valve on the side of the piston head just below the thumb ring. The syringe can be used for a single injection by unscrewing the side outlet and screwing in a plug. Attached to the side outlet is eighteen inches of non-collapsible rubber tubing having at the end a sinker containing a screen to filter the solution.

The solution to be injected is placed in a glass tumbler. Both the syringe and the sinker are placed in the solution. The syringe is filled and emptied several times to clear the system of air. The connecting tubing permits continuous injection. (Fig. 3.)

In diminishing order of preference for injecting are the 10 cc. Luer-Lok syringe with ears and metal plunger, the 20 cc. all glass eccentrically placed tip syringe, the 20 cc. centrally placed tip syringe and lastly, the 50 cc. all glass centrally placed

mentioned because they are quite adequate when the other syringes are not available.

Traction is put on the plunger to ascertain the presence of bleeding which is a contraindication to continuing with the injection. The most common sources of the bleeding are from the traumatized structures of the sacral canal caused by the passage and scraping of the epidural needle. The injected fluid may seep into the vascular system through these traumatized areas. Rarely is a large enough blood vessel born to allow for the direct introduction of the needle.

On seven occasions it was believed that a passage had been forced through the dura and pia arachnoid into the sub-arachnoid space and cerebrospinal fluid returned. Rarely, when the subarachnoid space extends below the first sacral segment, may the needle be directly introduced into that space. The procedure should be interrupted following such an occurrence.

Frequently instead of entering the canal, the needle glides along the top of the sacrum. When the fluid is injected a swelling of increasing size is immediately seen developing over either side of the sacrum and lower lumbar area, or on both sides. The unilateral swelling is due to the deviation of the needle to either

side of the midline. When the needle is centrally placed the swelling is diffuse over the whole sacrum. There is seldom following an injection are often beyond what could be objectively expected, unless we assume that the injection in

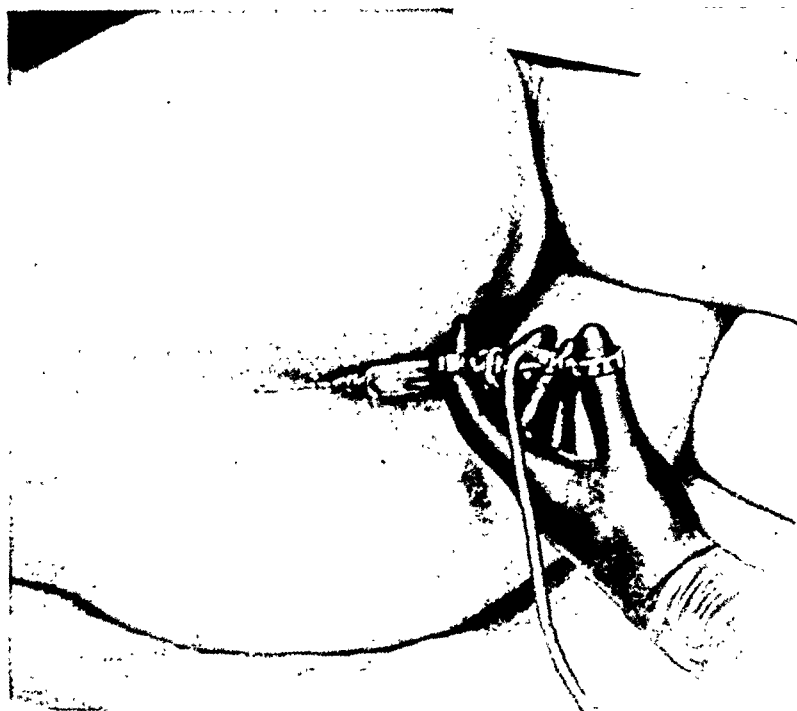


FIG. 3. Technic of caudal injection. Continuous flow syringe is shown attached to needle. Side tubing goes to reservoir of solution.

any associated pain and only a sensation of tension or tightness. No untoward effects following such malposition of the needle have been noted.

For the first four years normal saline was the injected fluid. Novocaine (1 per cent) in normal saline was used for the next two years. Metycaine (¾ per cent) in normal saline has been the solution of choice for the past year. These anesthetic agents have been added to allay the pain associated with the injection. At times the pain is quite severe. Also the anesthetic effect is an adjuvant to treatment. The vicious cycle of pain and muscle spasm is broken with resultant greater relaxation and longer periods of freedom from pain. These periods of relief give exhausted patients a chance for needed rest and sleep. It reassures them and gives them cause for optimism which attitude is conducive to improvement.

The period and degree of improvement

in addition to removing a primary cause of the sciatic pain such as peridural adhesions, and a secondary cause, pain due to spasm, also had a positive psychotherapeutic effect. It is believed that the result obtained is due to the above factors plus a number of other causes which are as yet not clear. The peridural adhesions which may be severed are most likely present about the nerve roots close to their entrance into the intervertebral canal. Adhesions about nerves are known to cause edema through the obstruction of free fluid flow in the nerve by cutting off the intrinsic blood and lymph circulation of the nerve and causing direct damage to the nerve by compression. This is particularly true in the rigidly or semi-rigidly contained spaces formed by the firm investiture of nerves by sheaths and dura.

Before ¾ per cent metycaine was used 1½ per cent metycaine was tried on three

patients. All three had mild shock reactions. The third manifested in addition a panic reaction as the anesthesia extended up to the nipple line. After the injection of  $\frac{3}{4}$  per cent metycaine the anesthesia may be complete from the umbilicus down, although usually it is limited to the legs. Even with  $\frac{3}{4}$  per cent metycaine, mild shock may occur but this is mainly due to several other factors.

When normal saline alone was used and injected with a 50 cc. syringe, three patients went into moderate shock and six more had mild shock. It was believed that this was due to the reaction to pain caused by the rapid introduction of the fluid, the acute exaggeration of the sciatic pain due to the sudden freeing of adhesions in and about the epidural space, and by the compressing effect of the injected fluid on the subarachnoid space and hence on the spinal cord and nerve roots. Another cause for shock, as well as headache, is the sudden distention of the epidural space acutely compressing the subarachnoid space and elevating the spinal fluid pressure. This sudden increase in spinal fluid pressure has been checked by the simultaneous placement of spinal and cisternal needles at the time of the epidural injection.

Also rents in the dura and pia arachnoid may occur after the initial check and form a passage into the subarachnoid space. It is, therefore, necessary to recheck during the procedure by frequent traction on the plunger of the syringe to determine whether a passage has been made into the subarachnoid space. This can be verified by the presence of cerebrospinal fluid in the aspirating syringe. Metycaine in varying amounts might thus reach the subarachnoid space and be another shock causing factor and also explain the extensive anesthesia up to the umbilicus and in one case up to the nipple line.

The whole procedure should not take more than thirty minutes, eight to twelve minutes being required for the actual injection. The injections are given three

times weekly on alternate days. The same number of injections over a longer period are much less effective. Consecutive daily injections are beyond the patient's tolerance. The amount of fluid injected may be as little as 50 cc. although in most cases 100 cc. is injected. The interruption of the injections, at lesser injected amounts, is determined by the patient's reaction to pain and his mental response. The number of injections is usually between four and six, although up to eleven have been given and as few as three, with good results. Less than three were given because the patient interrupted the treatment or the reaction was so extreme that it was deemed advisable to stop.

Epidural injection was our treatment of first choice. The only adjuvant treatment was a bed board under a firm mattress and sedation. Many patients had been treated before or after with diathermy, fever therapy, high vitamin diets and parenteral vitamins, Buck's extension, prolonged bed rest, full body casts, orthopedic manipulations and a host of other measures. Many had been investigated for space displacing lesions impinging on the spinal canal and for a number of other possible conditions.

Injection therapy is the simplest, least expensive of all the therapies and fraught with the least dangers. The results of therapy can be determined in a short time.

The patient should be at rest horizontally for at least one hour thereafter because of the occasionally delayed shock reactions or the development of an extensive anesthesia. The reassurance of the physician that these late manifestations are not causes for concern is usually sufficient to allay the patient's apprehensions. If this previous reassurance were not given, the disturbance would be quite marked with hospital patients but even more disturbing to out-patients in whom these reactions occurred on their way home or at home. On two occasions anesthesia lasted twenty-four hours, and on six others up to four hours. Usually the anesthetic effect disappears in one to two hours. Only two



patients were treated as out-patients and these after they had been started on treatment in the hospital. Epidural therapy could easily be carried on as an out-patient procedure entirely or to shorten hospital stay once the treatment has been initiated.

Results have been found to be better if during the injection there is an acute exacerbation of the whole symptom picture and exceeding it in severity, particularly of the pain radiating down the involved leg. The relief may last from three to six hours and frequently for twenty-four hours. Often the pain will radiate down the opposite leg or up the back or down both legs and up both sides of the lumbar spine. The best results follow when the pain is sharp, lancinating and extends to the heel, and also when the relief is significant after the initial or first few injections. Often the pain felt in the hip during the first injection gradually extends down the leg with succeeding injections. Shortly thereafter the pain starts leaving the area about the sciatic notch, then the posterior aspect of the thigh and upper leg and disappears last from the foot.

The relief obtained after the acute effects of the injections have passed often follow this sequence. The severity of the pain abates. The defensive flexion at the hip and the knees, as well as the associated sciatic scoliosis, become less marked. The patient can now sleep without the terror of being awakened by an exacerbation of pain due to getting into the "wrong position." The associated spasm of the erector spinae muscles, as well as the tilt of the pelvis, becomes less marked. Pressure tenderness along the course of the sciatic nerve diminishes. The patient can begin to straighten up and walk erect with less of a limp. The range of flexion at the hip of the extended leg increases. Numbness along the posterior aspect of the leg disappears. Even such extensive sensory loss as to involve L 3, 4, 5, and S 1 and 2 dermatomes have disappeared. The coldness and cyanosis commonly present and involving the foot and lower leg becomes much less

marked. The pain first leaves the areas close to the sciatic notch and moves distally so that the patients often say "the pain is moving out of my leg right through my toes." It is only after the above sequence has occurred that the patient can actually realize how much weakness there is due to disuse and actual nerve involvement. Although much tonus and power returns rapidly, it may take months of graduated exercises to bring the involved leg back to an approximate normal. Only persistent efforts on the part of the patient can lead to the complete recovery of muscle power and muscle mass.

The results obtained are classified as cured and improved, markedly, moderately, slightly and none. (Table II.) No correlation is attempted between the severity of the symptoms and the results. The initial relief may be quite dramatic in severe cases but the end result may vary as with the milder cases. Cure only refers to the symptoms of the present attack and not to the signs which take a variable period to disappear. When all the symptoms have entirely disappeared the result is considered as a cure. This explains the small number in this category and the much larger numbers in the categories of marked and moderate improvement.

TABLE II  
Result

No. of Cases

Cure.....	8
Marked improvement.....	41
Moderate improvement.....	45
Slight improvement.....	17
No improvement.....	5

Another factor in the low percentage of cures and good results is the patient's desire to get back to work as soon as possible or at the first signs of relative comfort. Also the results were tabulated on the basis of the condition on discharge. Since many of these patients would return or would be returned to this hospital if they had a recurrence, it may be assumed that further improvement took place and that a careful follow-up study would improve our statistics. Follow-up on a small number of our patients verified this supposition.

If there is still even some slight occasional pain, soreness, aching, coldness or numbness of the foot, the result is classified as markedly improved. When any of the above are still present to a moderate degree, the result is classified as moderately improved. Patients with marked and moderate improvement can and do return to their previous occupations, often of a strenuous variety. These patients first start at light duty and resume regular duty in one to two months. Patients with only slight alleviation of symptoms cannot return to work. As the tabulation indicates most patients obtain some degree of relief and only a few get none at all. In such cases one form of treatment after another is instituted. These treatments have been listed above. The complexity of the problem is clearly demonstrated by the fact that even after all our efforts, too many patients remain incapacitated, have no relief or are left with some symptoms and signs or have recurrences.

Failures or poor results were frequent when significant psychologic problems were present. Most of these cases had erector spinae spasm, scoliosis and sciatic pain and were diagnosed as sciatic neuralgia. The low percentage of any improvement following epidural injections in cases in which there is a large functional element, belies the value of such a measure as a therapeutic aid. Careful follow-up studies of patients treated by physical or medical means for physically manifested psychologic disorders have revealed similar poor results. There is transient improvement of variable duration with remission or with the substitution of a new set of physical or mental symptoms. The treatment of psychologic disorders is psychotherapy.

In 294 cases one or two epidural injections were given for diagnostic and/or therapeutic purposes with almost dramatic relief in sixty-nine cases and a variable degree of relief in the remaining number. These positive results might be considered valid in about half the cases. However, it was believed that patients receiving less

then three injections should be excluded from the series. Too many factors could account for such dramatic results after only one or two injections. These factors are partially organic but essentially psychological. One factor is the extreme suggestibility of certain patients. Some patients feared the pain of the injection or "needles" so much they refused the treatment altogether or stated they were entirely relieved of pain after one or two injections. Further observation of these patients revealed that many of them still had symptoms and signs.

Whether the causes for the pain have been removed is difficult to verify. A cure is no assurance that recurrence will not occur. In fact they are quite common. There were three recurrences in our own previously "cured" patients who had been completely relieved through treatment. The result of treatment with the second series of epidurals was not as good as on the first occasion. Results are better when the first attack is treated than with recurrences. By the time a second or subsequent attack has occurred irreparable nerve damage has occurred, as well as extensive fibrosis in the muscles.

During the same seven-year period as this series ran, 63,452 cases were admitted to the hospital for all causes. It may be estimated that for every patient treated for the complaint of sciatic pain on the service of neurology and psychiatry there are five others treated on all other services. During this period the total number of cases treated by the service of neurology and psychiatry was 5,783. The number of cases treated for the complaint of sciatic pain as part or all of their symptom picture was 410. Twenty-seven per cent of these cases were treated by epidural injections. Patients with sciatic pain treated on that service would make up 0.07 per cent of the total admissions. An estimated percentage for the whole hospital would be 0.04.

In 294 cases a simultaneous epidural injection and lumbar puncture was performed as part of the investigation for

herniated nucleus pulposus. A pneumorachigraphy was performed in 126 of these cases and only two herniated discs were found.

A total of 526 epidural injections was given in the series, an average of about 5 per patient. In the cases receiving less than three a total of 466 injections were given making an overall total of 992 epidurals in seven years. These epidurals were administered by twelve different operators.

The preponderance of males in this series is in large measure due to existing laws relating to eligibility for treatment by the U. S. Public Health Service. There were only five women in the series.

TABLE III

Decade	No. of Cases
10-20.....	1
20-30.....	15
30-40.....	34
40-50.....	49
50-60.....	13
60-70.....	4

The concentration of cases in the third and fourth decades (Table III) may be due to years of strenuous physical labor, multiple back traumas and the aging process.

Heavily muscled men seemed more prone to sciatic symptoms and sequelae from back injuries. The youngest patient was nineteen and the oldest sixty-seven. There were fewer patients in the older age group because many of our beneficiaries have with increasing years of service and through advancement some less strenuous type of occupation.

In sixty-two cases the right side was affected and in forty-eight cases the left. There was bilateral involvement in five cases. In eleven cases the second attack was treated and in two cases it was the third. In one case it was the fifth attack and in another the seventh.

## SUMMARY

In seven years 486 epidural injections have been given to 116 patients with the complaint of sciatic pain.

The favorable results warrant the selection of this form of treatment for a fair and early trial.

A cure resulted in eight cases, marked improvement in forty-one, moderate in forty-five, slight in seventeen, and no improvement in five cases.



# TRAUMA OF THE THORAX\*

## COLLECTIVE REVIEW

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NEW YORK, NEW YORK

THE modern industrial era plus the present military conflict has increased the incidence of all injuries. The use of bursting bombs, artillery and machine gun fire, accompanied by falling masonry, has caused a high percentage of immediate fatal chest wounds.

This paper is a review of thoracic trauma varying from a simple contusion to a marked compression; from a superficial laceration to a through-and-through perforation.

In thoracic trauma the symptoms of greatest importance are dyspnea and cyanosis. Butler<sup>22</sup> contends that a certain degree of shock is desirable in these cases as the hemorrhage from the injured soft parts often subsides and remains controlled unless too active therapy is instituted.

The first aid treatment<sup>47</sup> of thoracic injuries must deal with the urgent condition of (1) shock and hemorrhage, (2) the altered intrathoracic physiology and dynamics. First aid treatment should minimize any additional contamination and help make the patient safer for thoracic surgery.

The disturbed intrathoracic dynamics may in itself be the chief cause of shock, and it may be impossible to combat shock until the heart and lungs have been put in working order. Unlike injuries to less vital parts local treatment may take precedence over general treatment. Sudden pressure changes must be corrected in the shortest possible time with the least possible surgical trauma.

An extensive crushing injury can occur within the thoracic cavity but with little damage to the chest wall. Trauma may

involve the pleura and lungs singly or in combination.

Trauma requiring immediate intervention are wounds of the heart and esophagus, hemorrhage from an intercostal, internal mammary or pulmonary vessel, compound fractures, tension or open pneumothorax and mediastinal emphysema. These emergencies usually arise as a result of a penetrating trauma. Cardiac and esophageal trauma has been omitted in this paper and is to be treated in a later publication.

In discussing the treatment of the various forms of chest injuries, a number of classifications have been suggested; however, these are unsatisfactory because of the multiplicity of these lesions and their complications.<sup>2,11,12,13,18,42,72,110,131</sup> For simplicity the types and treatment of the various thoracic trauma are considered under separate headings. It must not be assumed that these lesions are the only injury sustained; there may be injuries to other parts of the body.

## ANATOMY AND PHYSIOLOGY

The lungs lie free within the corresponding pleural cavity and are attached only by their root and the ligamentum pulmonale.<sup>33</sup> The apex of the lung rises above the level of the oblique first costal arch to the full height of the cupula pleurae. It protrudes through the superior aperture of the thorax into the root of the neck for a distance of one to two inches above the anterior extremity of the first rib. This may be of clinical importance in penetrating wounds of the supraclavicular area.

\* From the Surgical Service, Reconstruction Hospital. Acknowledgment is made to Dr. Frank H. Netter for his helpful anatomical and physiological contributions.

The hilum is a wedged-shaped depression within which two pulmonary veins, the pulmonary artery and the bronchus, enter and leave the organ.

The diaphragm comes upward, infringing upon the long axis of the thorax, leaving at its periphery the deep costophrenic sinus, deeper behind than in front.

A cross section of the chest shows the vertebral column projecting forward into the cavity, so that the distance between the sternum and spine is relatively small, about four to four and one-half inches. In each side lies a large paravertebral gutter which accommodates much of the lung tissue. It is in these areas that fluid tends to accumulate in the pleural cavities and where aspiration or drainage will be most effective.<sup>144</sup>

The lungs are held out against the chest wall in a state of tension by the negative pressure in the pleural sacs, and these elastic organs pull like evenly balanced springs on each side of the mediastinum. In the body the lungs fill the pleural cavity completely, but constantly tend to collapse to their own normal size. The elastic recoil of the lungs creates a suction in the pleural space which results in a negative intrapleural pressure of 5 mm. of mercury. During growth, since the thorax enlarges at a slightly faster rate than the lungs, the tension on the latter and the resulting intrapleural vacuum increases.

#### SIMPLE FRACTURES

1. *Ribs* (Fig. 1). A direct injury to the chest wall may produce simple fractures of the ribs without involvement of the lung or its visceral covering, but it always involves the parietal pleura. The fracture may occur anywhere along the course of the rib, the cartilage or at the costochondral junction.

Compression of the thorax in the anteroposterior plane causes a lateral widening of the thorax; and if a fracture results, it is usually in front of the angle of the rib at a distance from the force. Muscle

violence,<sup>79</sup> as a rule, breaks the rib anterior and sub-periosteally, the seventh to eleventh ribs being most frequently involved.

A single fracture is usually end-to-end; multiple fractures may overlap. The first two ribs are rarely injured, the sixth, seventh and eighth are most commonly fractured.

Diagnosis is easily made on the history of trauma to the thorax followed by persistent pain, shallow breathing, and inclination toward the affected side. Pain is aggravated by respiration, coughing, sneezing, etc. The degree of pain depends on the amount of injury to the ribs, as the lung and the visceral pleura are insensitive.<sup>145</sup> Roentgenograms in three planes will usually confirm the diagnosis.

*Treatment.* Treatment should be instituted regardless of the roentgenographic findings, as callus formation may make its appearance at a later date, in spite of previously reported negative x-ray plates.<sup>146, 167</sup> It is impossible to immobilize the ribs completely, but nature by muscle spasm tends to immobilize the ribs partially, and proper strapping of the chest wall aids considerably. Absolute immobilization is not essential for proper union. The strapping should encircle at least two-thirds of the circumference of the chest, beginning and ending on the sound side. Blades<sup>12</sup> advocates partial immobilization of the entire thorax regardless of the level of the fracture with a single strip of adhesive which encircles the lower costal margin. Strapping reduces the tidal and vital capacity and lessens the effectiveness of the cough.

Latteri and Nicolosi, Italian surgeons, recommend alcoholization of the intercostal nerves to produce immobilization of the involved ribs.

The afferent painful stimuli can be interrupted at the site of fracture by means of local anesthesia. Procaine solution or a double solution containing 5 per cent procaine hydrochloride and 1 per cent eucupine dihydrochloride to which epinephrine hydrochloride is added may be used.<sup>67, 69</sup>

Other methods recommended are binders, corsets and the "Sam Browne" plaster belt.<sup>136, 137, 163, 173</sup>

2. Dislocations at the costovertebral joint are rare and are usually overlooked. This entity must always be borne in mind when a patient complains of pain encircling the chest at a definite level due to involvement of a nerve radicle. One or more ribs may be torn from their vertebral attachments as a result of direct violence. Immobilization by adhesive strapping is generally sufficient to alleviate the pain element.

3. Fracture and dislocation of the costal cartilages occur mostly in young adults. Costal cartilages are not visible on the roentgenogram unless they are calcified.<sup>89</sup> Diagnosis is based on the history and physical findings. Deformity or obvious dislocation may be present.

*Treatment.* Reduction of the dislocation is attempted by drawing the shoulders back and manipulating the displaced cartilage back into its normal anatomical position. This is supplemented by adhesive plaster immobilization.

4. Fractures of the sternum are usually caused by direct violence, often the result of an automobile accident when the driver's chest is forced against the steering wheel. The underlying mediastinal contents may be injured. The fracture is generally transverse and most frequently occurs near the junction of the manubrium and body of the sternum. The upper fragment is usually displaced posteriorly, and the extent of the deformity will depend upon the amount of displacement. Pain is intensified by sneezing, coughing, etc. Extensive x-ray study, particularly in the lateral plane, is essential.

*Treatment.* Reduction of this type of fracture is often difficult using the closed methods. Hyperextension of the neck and thorax plus manipulative reduction should be attempted before instrumental or operative procedures are used.<sup>119</sup> Corkscrew or hook traction may be helpful in some cases.<sup>129</sup>

## COMPLICATED FRACTURES

1. A depressed fracture does not necessarily traumatize the underlying pulmonary tissues. When the depressed fragment does tear the underlying lung, it may result in a hemothorax, pneumothorax, subcutaneous emphysema or a combination of these pathological entities. (Figs. 2 and 3.)

*Treatment.* Treatment in these complicated injuries should be primarily the prevention and treatment of shock. Conservative measures should always be employed. The necessity for surgical intervention will depend upon the physical findings. Depressed fragments involving the pleuropulmonary structures may require elevation and repair of the damaged tissues.

2. Stove in chest injury<sup>12</sup> may follow direct violence to the chest wall.<sup>129</sup> It usually involves several ribs, at two points, along the course of the rib. The loose fragments become depressed during inspiration and bulge during expiration. This condition may or may not be associated with an underlying pulmonary pathological condition.

*Treatment.* Conservative treatment consists in strapping the chest wall to stabilize the paradoxical motion of the mobile thoracic wall. If conservative measures fail to relieve the respiratory embarrassment, elevation of the loose fragment should be undertaken. Elevation may be accomplished by means of perichondral wire suture, towel clips or open fixation.

3. Sternochondral fractures with depression of the sternum is generally accompanied by some injury to the underlying mediastinum and its contents. The depressed manubrium may interfere with the venous return in the superior mediastinum. Cardiac embarrassment must be relieved by elevation of the sternum; this may be accomplished by towel clips, screw traction or open fixation.<sup>56</sup>

4. Compound fractures of the ribs rarely occur without injury to the underlying

pleuropulmonary structures. When they do occur without such involvement, they are usually tangential as a result of non-penetrating wounds caused by fragments of high explosive missiles and should be treated in the same manner as wounds of other parts of the body.<sup>10</sup> Thorough wound excision, removal of devitalized tissues, foreign bodies and bony splinters, implantation of local sulfa drugs<sup>21,23,55,73,77,84,88,126</sup> and closure of the skin by either primary suture or packing should be carried out. Care must be exercised not to enter the pleural cavity. When there is considerable loss of substance, the rib above and below may be drawn together by sutures placed around them.<sup>14</sup> Wounds over the posterior thoracic wall are more susceptible to infection due to the massive musculature of this area and the presence of fascial planes which permit extension of blood and infection.

The more common type of compound fracture of the rib involves the underlying pleuropulmonary structures. Thoracotomy is necessary to determine the possibility of lung injury by an indriven rib fragment or missile. In such cases exploration of the pleural cavity is carried out in addition to the above mentioned débridement. The pleural cavity is cleared of bloody fluid and accessible foreign bodies. The pulmonary wounds are débrided and wedge resection of the lung performed if necessary for the removal of devitalized tissues. Hemostatic suture of the lacerated lung with airtight closure of severed bronchi are effected. The wound is drained subcutaneously and the pleural cavity drained with a tube under water. Closed drainage for forty-eight to seventy-two hours is advisable following exploration with extensive débridement of the lung and pleural cavity. The evacuation of exudates will prevent infection and reduce pulmonary pressure.

**Contusion.** Contusion of the thorax with or without osseous involvement may result in a traumatic pleurisy. This usually subsides within seven to ten days, unless

complications set in. Contusion may be followed by atelectasis, pneumonia or activation of a quiescent tuberculosis.<sup>19</sup> A number of observers have described so-called contusion or traumatic pneumonia.<sup>124,139,152</sup>

**Treatment.** Symptomatic strapping and sedation may be necessary to allay the pain.

**Pulmonary Laceration.** Lacerations of the lung are more commonly present in penetrating injuries, but may also be caused by indriven rib fragments penetrating the underlying lung. This often results in a hemothorax, pneumothorax or subcutaneous emphysema. Laceration of the lung is to be suspected if there is bloody expectoration and signs of a hemothorax. In some instances damage to the intrathoracic structure can occur in the absence of demonstrable evidence of thoracic wall lesions.

**Treatment.** Conservative treatment is to be followed unless active bleeding or signs of obstruction of the venous return to the heart are noted.

Graham<sup>63</sup> believes that environmental facilities, the presence of surgical equipment and adequate assistance should govern the decision between conservative and operative treatment.

Simple suture of the laceration and ligation of the bleeding vessel with reinflation of the lung will be sufficient to control the majority of penetrating wounds. Accurate identification of a bleeding point in lung parenchyma may be time consuming and difficult. In those cases the bleeding can be controlled by a continuous mattress suture into the lung substance.

Extensive pulmonary lacerations may require partial or complete lobectomy or even pneumonectomy. Bleeding from the lung may require application of a tourniquet to the root of the bleeding lobe to facilitate suturing of the laceration.<sup>95</sup> If difficulty is experienced in controlling hemorrhage from the lung parenchyma, the lung may be partially exteriorized and sutured under direct vision.<sup>35</sup> This has the added advantage of fixation of the lung

with consequent stabilization of the movable mediastinum. All pulmonary wounds should be completely closed. When an accumulation of air or blood is to be anticipated, closure with under water drainage as a safety measure is instituted.<sup>115</sup> Closed drainage prevents entrance of air into the pleural cavity but allows escape of fluid and air. This drainage is maintained about forty-eight hours.

Once an exploratory thoracotomy is decided upon, a Robert Nelson hilar tourniquet should be held in readiness for those patients requiring resection of a lobe or even an entire lung.<sup>19</sup>

#### HEMOTHORAX

Butler<sup>22</sup> maintains that a hemothorax (Fig. 4), in some degree, follows all chest injuries.

Hemorrhage is probably the most common finding in all injuries. In the thorax it may involve the vessels of the chest wall or more frequently the underlying lung parenchyma.<sup>1</sup> It may vary from a subpleural hemorrhage in simple contusions<sup>37</sup> to a massive fatal hemorrhage from the mediastinal or hilar vessels in severe injuries, involving an entire lobe or even both lungs.<sup>141</sup> Hemorrhage from the chest wall is usually caused by injuries to the intercostal, internal mammary and occasionally the azygos vessels. Arterial bleeding from the intercostal or internal mammary vessels occurs at a pressure six times as great as that of the pulmonary circulation, and thereby produces its signs and symptoms early.

Bleeding from the lung parenchyma is usually slow and involves the smaller pulmonary vessels. Hemorrhage from the large mediastinal or hilar vessels is generally severe and fatal.

The intercostal space is relatively safe as regards the risks of hemorrhage. The segmental vessels and nerves are under cover of the lower border of the corresponding rib.<sup>144</sup> The intercostal artery medial to the angle of the rib is approximately in the center of the intercostal

space, and from that point anteriorly the vessel progressively approaches the inferior border of the rib above, so that from the angle of the rib forward the vessel is under the edge of the rib in the subcostal groove and simple circumcostal massive suture may be insufficient.<sup>52</sup> The presence of a hemothorax, without fracture of a rib, as a rule excludes the intercostal vessels as the source of hemorrhage. The intercostal vessels are more frequently injured in compound fractures than in depressed rib fractures.

The increase in intrapleural pressure causes a disturbance of the cardiorespiratory physiology. There is diminution in the vital capacity with increased resistance in the pulmonary circulation. The resultant pressure on the central mediastinum interferes with the venous return to the heart, thereby causing diminution in the cardiac output. Death may result from respiratory and circulatory failure.<sup>45</sup>

Clinical manifestations are pleural effusion with displacement of the mediastinum away from the affected side; this displacement may be absent if there is considerable pulmonary collapse beneath the effusion. Objective signs of fluid are found in the form of dullness on percussion, diminished voice and breath sounds, which vary with the size of the effusion.

In both open and closed wounds of the thorax a hemopneumothorax may ensue from the entrance of air through the chest wound or escape of air from the lacerated lung. Radiographic examination reveals a diffuse shadow extending from the base upward, and encroaching upon the normally translucent lung. There is an obliteration of the cardiophrenic or costophrenic angles. In a hemopneumothorax a definite fluid level can be seen in the radiograph. It is important to remember that hemothorax may develop many days after the original injury.<sup>24</sup>

*Treatment.* The source and severity of the hemorrhage in hemothorax is the determining factor as regards treatment. Because the falling blood pressure and the



rising pressure in the pleural cavity tend to stop the hemorrhage, treatment should be expectant until either circulatory or respiratory signs and symptoms indicate change.<sup>74</sup>

Simple limited hemothorax can be treated expectantly.<sup>4,26,44,46,71</sup> A localized hemothorax without displacement of the apex beat can be left alone safely. Hemothorax produces a partial compression of the lung, which in turn arrests some of the hemorrhage.

Aspiration of blood should be avoided within the first forty-eight to seventy-two hours unless there are definite signs of cardiorespiratory distress. Aspiration can be performed in the seventh or eighth interspace in the midscapular line. Zenker<sup>172</sup> states that reaccumulation of fluid after aspiration is generally due to pleural irritation and not to recurrent bleeding. Aspiration of blood, followed by air replacement favors arrest of hemorrhage.<sup>9,54,76,111,146</sup> Recent articles, especially of British authors, favor this method of treatment.<sup>38,51,82,91,98,104,125,130,132,158</sup> This method is not attempted in hemothorax due to bleeding from the intercostal or internal mammary vessels. The aspirated blood from the pleural cavity provides an excellent culture medium,<sup>43</sup> and should be subjected to smear and culture study.<sup>45</sup> According to Foster<sup>53</sup> aspiration lessens the possibilities of adhesions and permits re-expansion of the lung and also enables visualization of foreign bodies by x-ray.

Thoracotomy is indicated for persistent bleeding from the vessels in the chest wall or pulmonary circulation. In open wounds, direct ligation or pericostal suture to the bleeding artery may be a lifesaving procedure. If the bleeding persists as evidenced by an increasing hemothorax, thoracotomy is indicated. This consists of wound excision, ligation of the bleeding vessels and wound closure without drainage when the pleuropulmonary structures are not involved. Hemorrhage from the internal mammary artery is to be suspected if there is a wound about 1 cm. lateral to the sternal

border with escape of bright red blood from the wound and not from the tracheobronchial tree. Fatal hemorrhage from an intercostal vessel may occur unless surgical ligation is performed.<sup>34</sup> A bleeding internal mammary artery must be ligated above and below the opening because of the double source of blood supply to these vessels.<sup>35</sup> Active reaccumulation of blood in the pleural cavity following aspiration suggests active bleeding and provides an urgent indication for thoracotomy. Death may result from increased intrathoracic tension.<sup>45</sup>

### PNEUMOTHORAX

A pneumothorax (Fig. 5) is an accumulation of air in the pleural cavity. It may be localized by adhesions, but more commonly air is distributed evenly throughout the entire pleural space. Pneumothorax may result from injury to the pleura with air entering the pleural cavity from without, or injury to the lung, bronchus or esophagus with air entering the pleural cavity from within. Occasionally, it may be caused by the tearing of pleural adhesions.

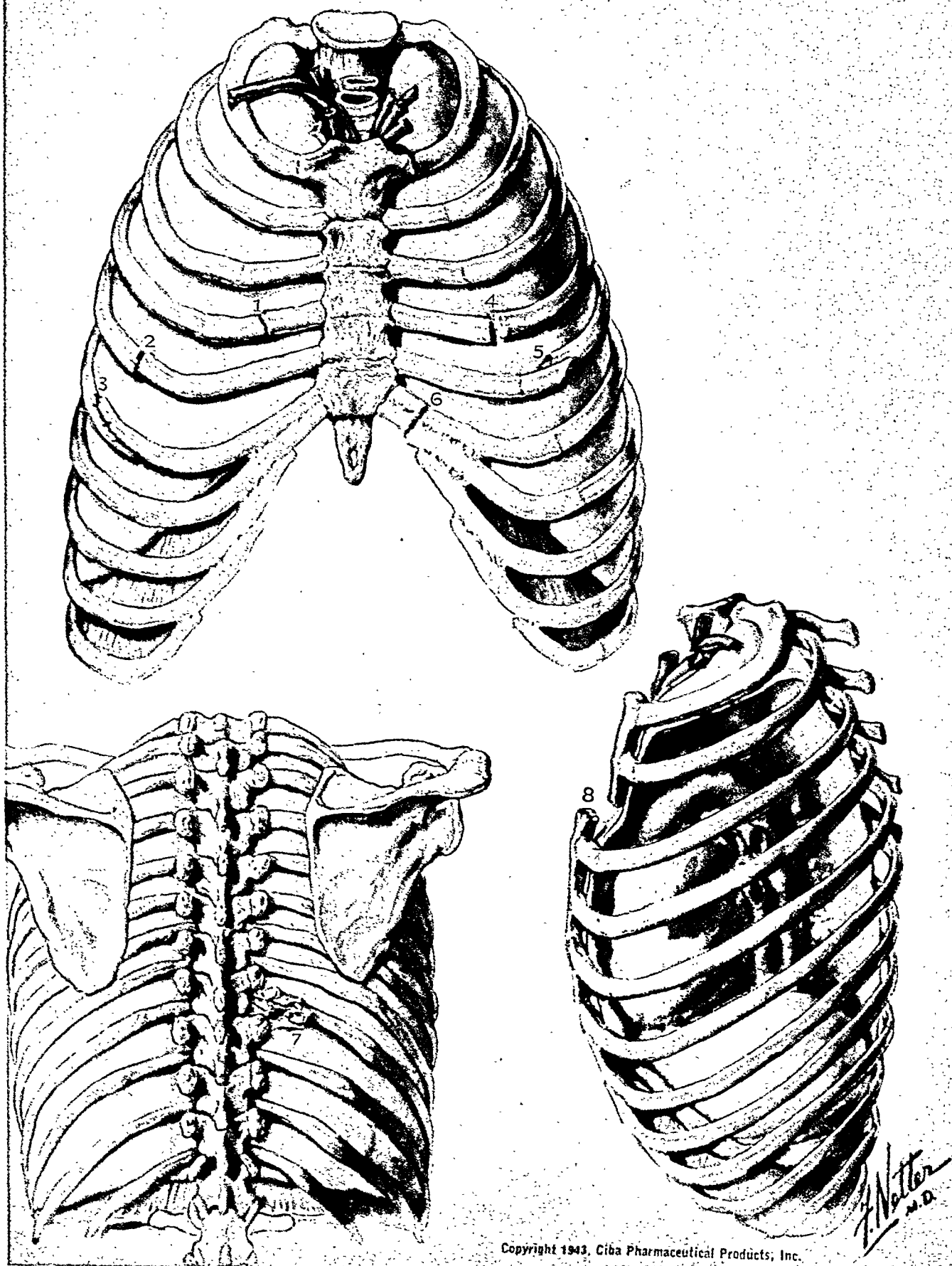
Symptoms of respiratory insufficiency, cardiac embarrassment and peripheral circulatory failure in the various types of pneumothorax depend upon the volume of lung that is collapsed, the rapidity of onset, the degree of mediastinal displacement and the initial vital capacity of the patient.<sup>53</sup> The objective signs are restricted motion of the affected side, hyperresonant percussion note, distant or absent breath sounds, and displacement of the apex beat and cardiac dullness to the contralateral side. X-ray reveals a structureless field in which lung details are absent. The outline of the ribs is sharply defined and the lung is collapsed toward the root. The trachea shows displacement to the opposite side.

*Types—Closed.* In this type the thoracic wall remains intact with air entering and leaving the pleural cavity during inspiration and expiration.

With the lung at rest, the intrapulmonic pressure is the same as that of the atmos-

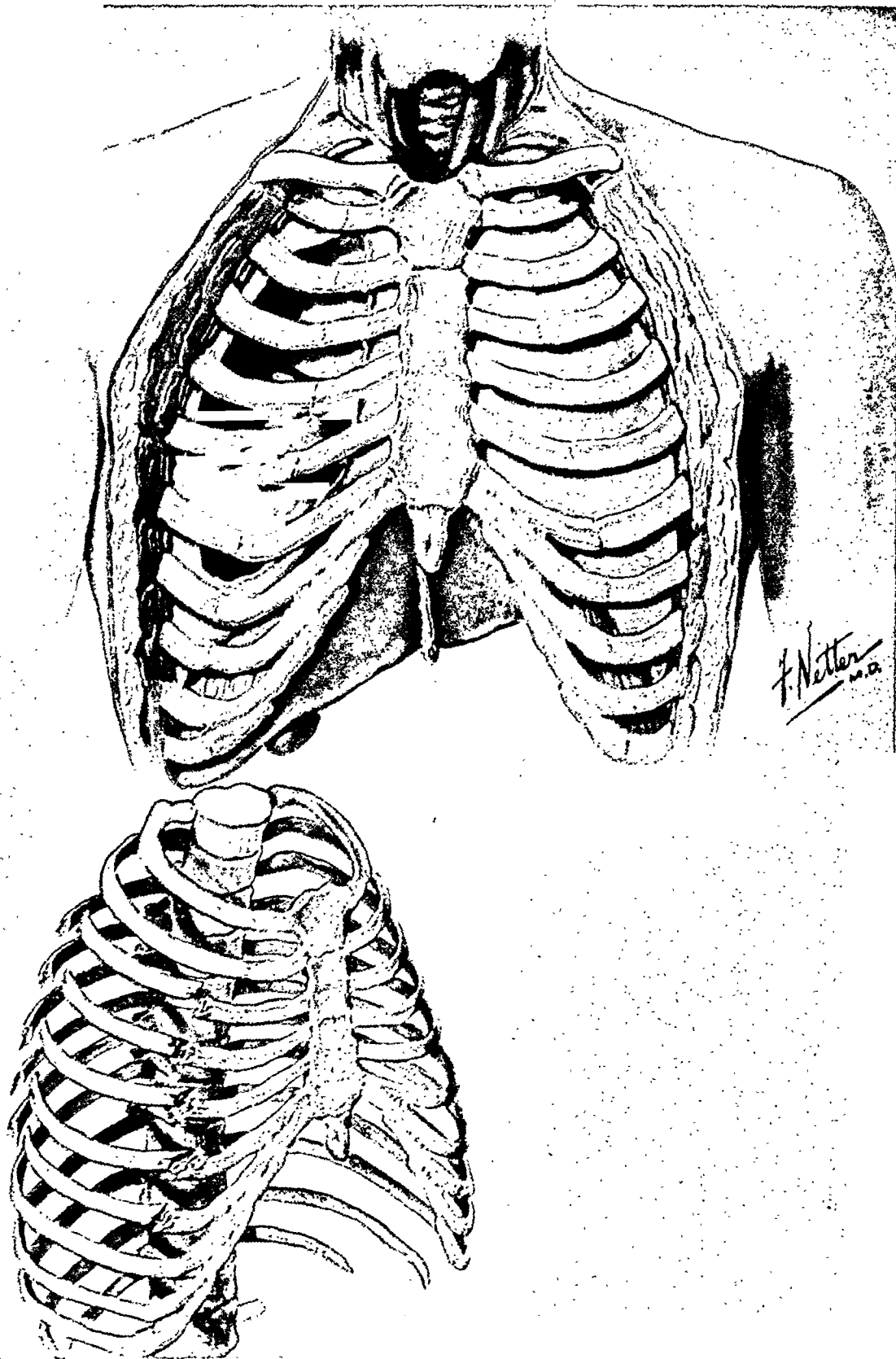
# Fig. 1—SIMPLE THORACIC CAGE INJURIES

Courtesy Ciba Pharmaceutical Products, Inc.



**Fig. 2—COMPLICATED THORACIC CAGE INJURIES**

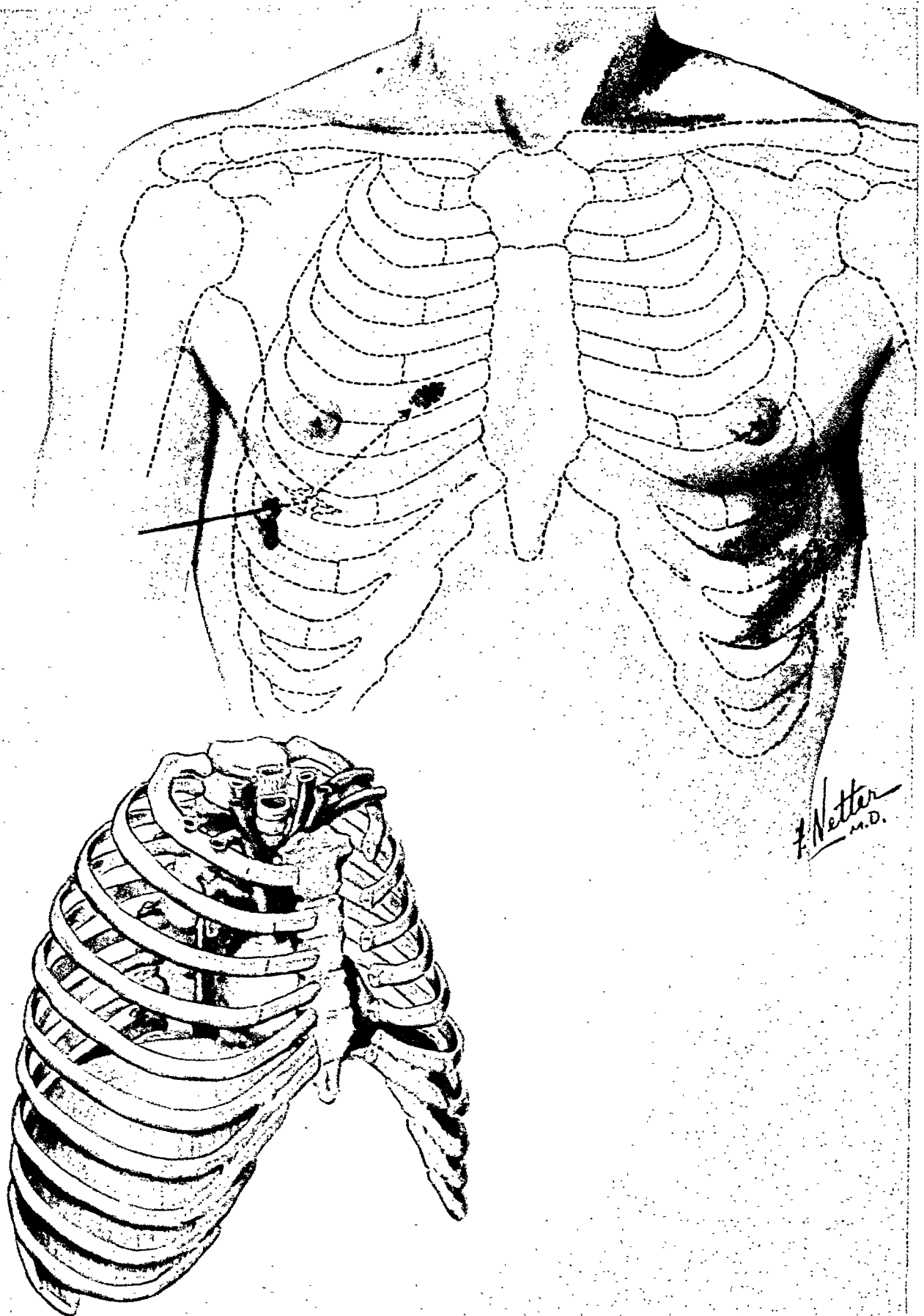
Courtesy Ciba Pharmaceutical Products, Inc.



# Fig. 3—COMPLICATED THORACIC CAGE INJURIES

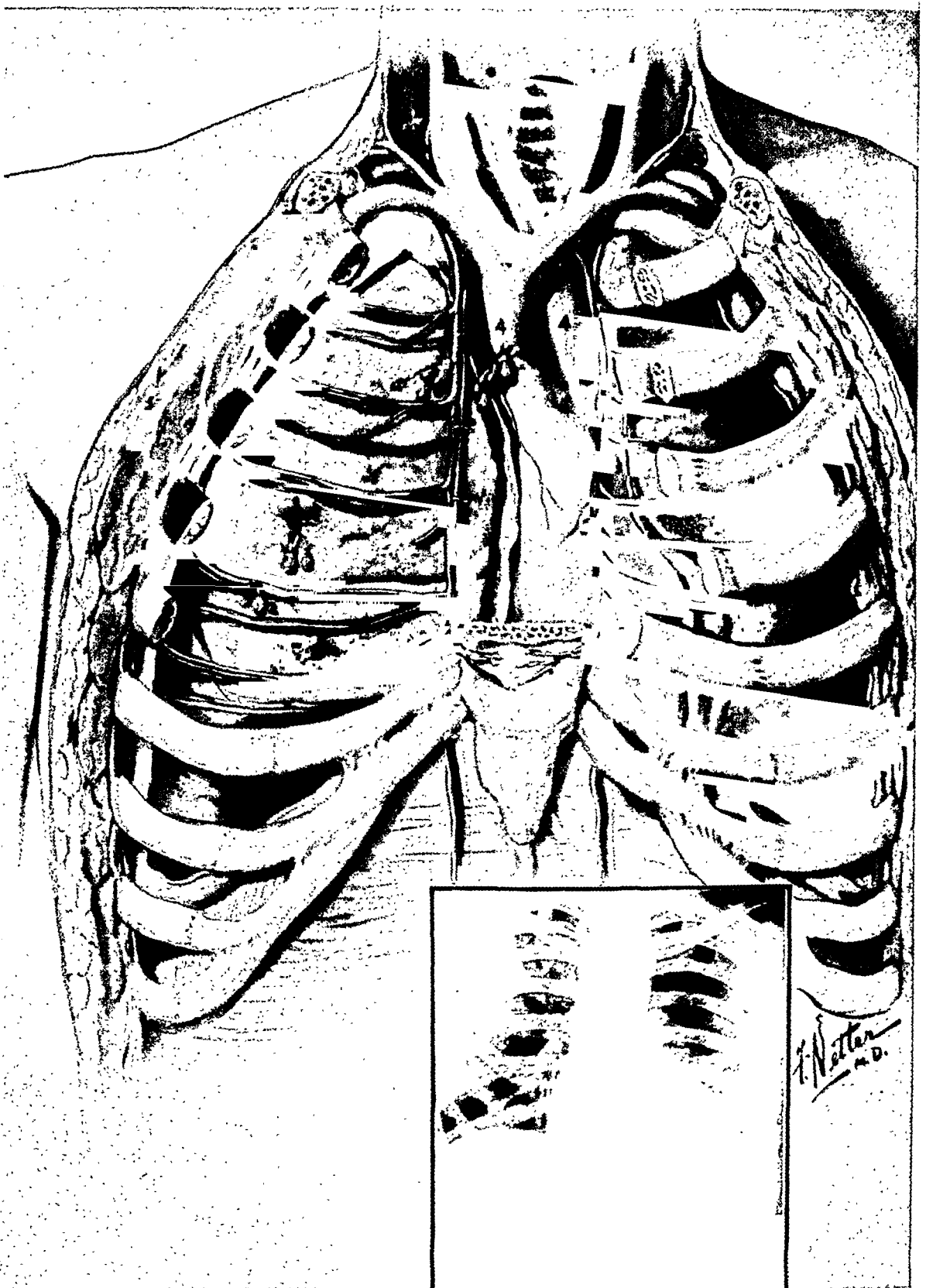
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Courtesy Ciba Pharmaceutical Products, Inc.



**Fig. 4—HEMOTHORAX**

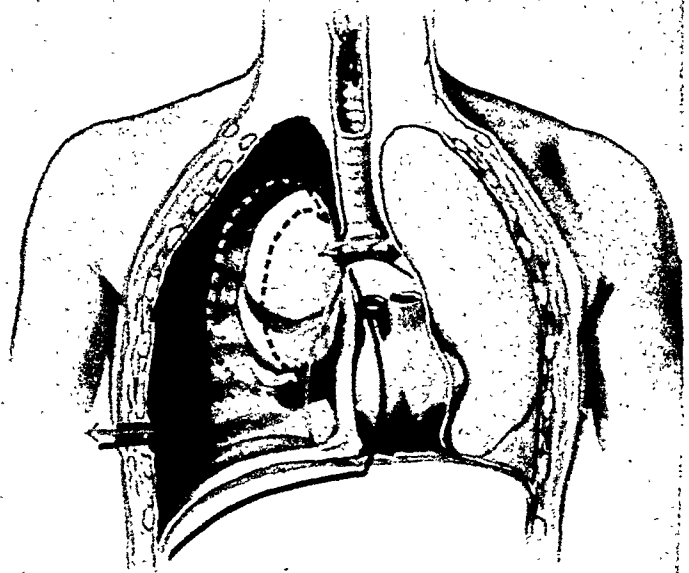
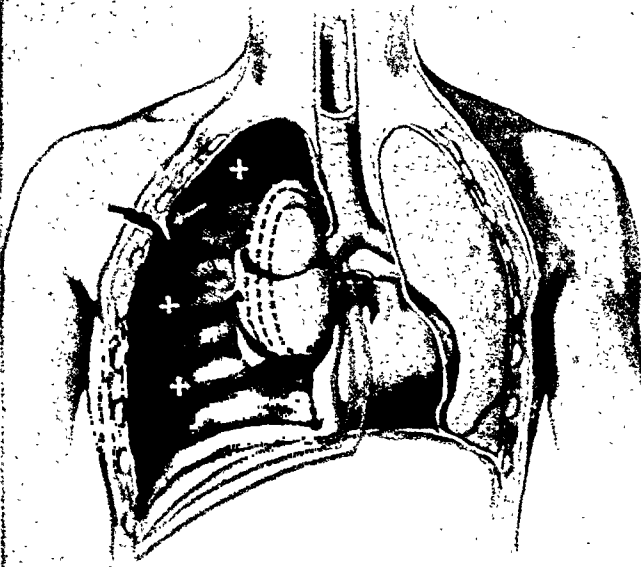
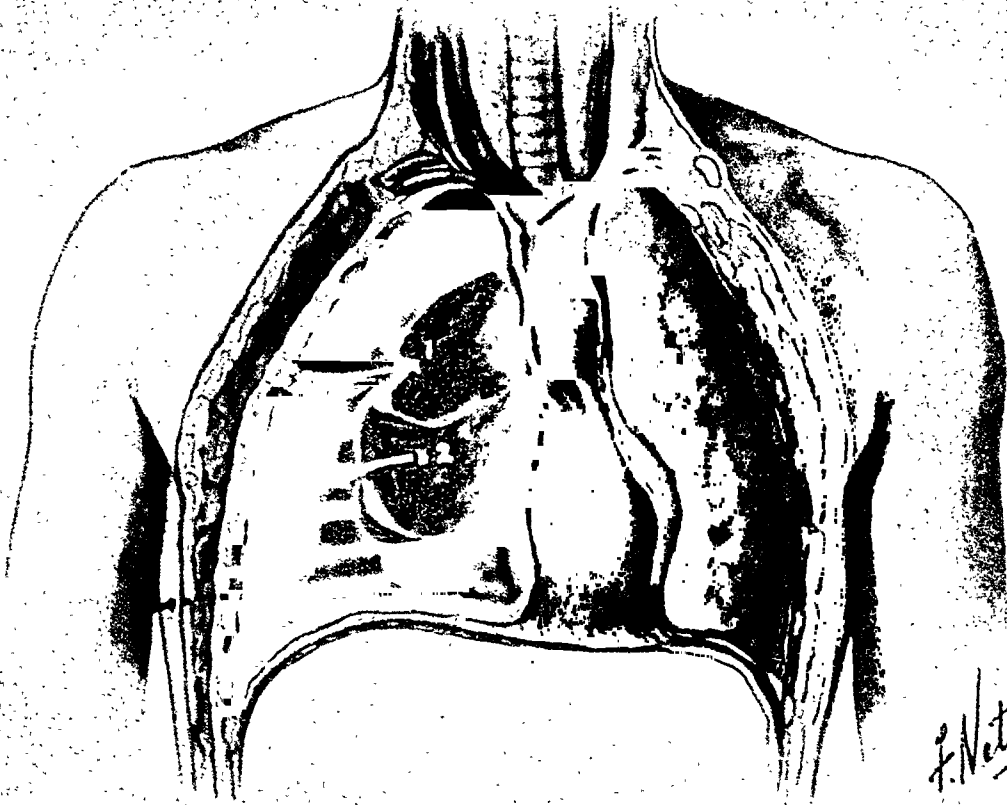
Courtesy Ciba Pharmaceutical Products, Inc.



# Fig. 5—PNEUMOTHORAX

## CAUSES AND TYPES

Courtesy Ciba Pharmaceutical Products, Inc.



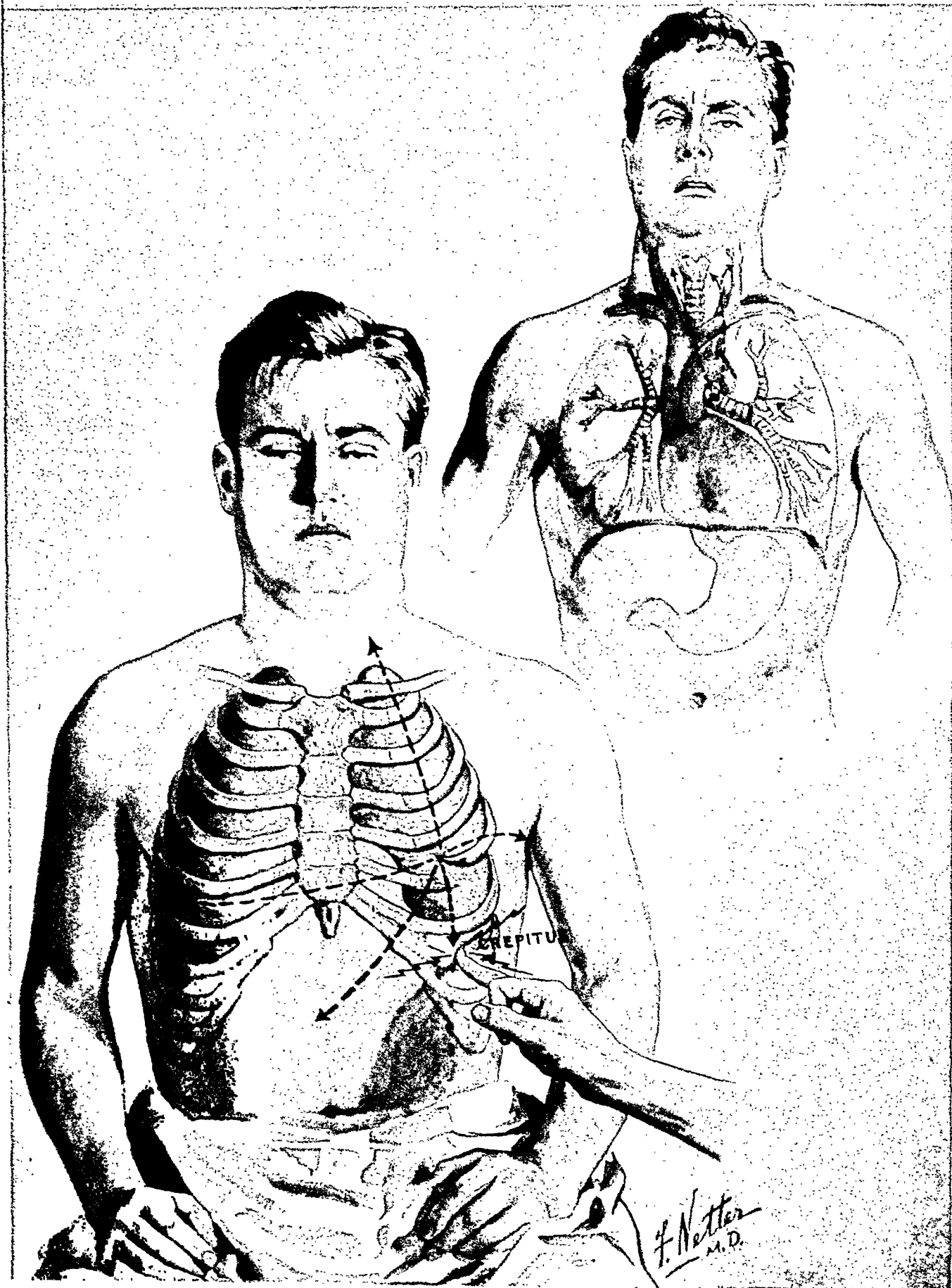
# Fig. 6—EMERGENCY TREATMENT OF PNEUMOTHORAX

Courtesy Ciba Pharmaceutical Products, Inc.



# Fig. 7—EMPHYSEMA

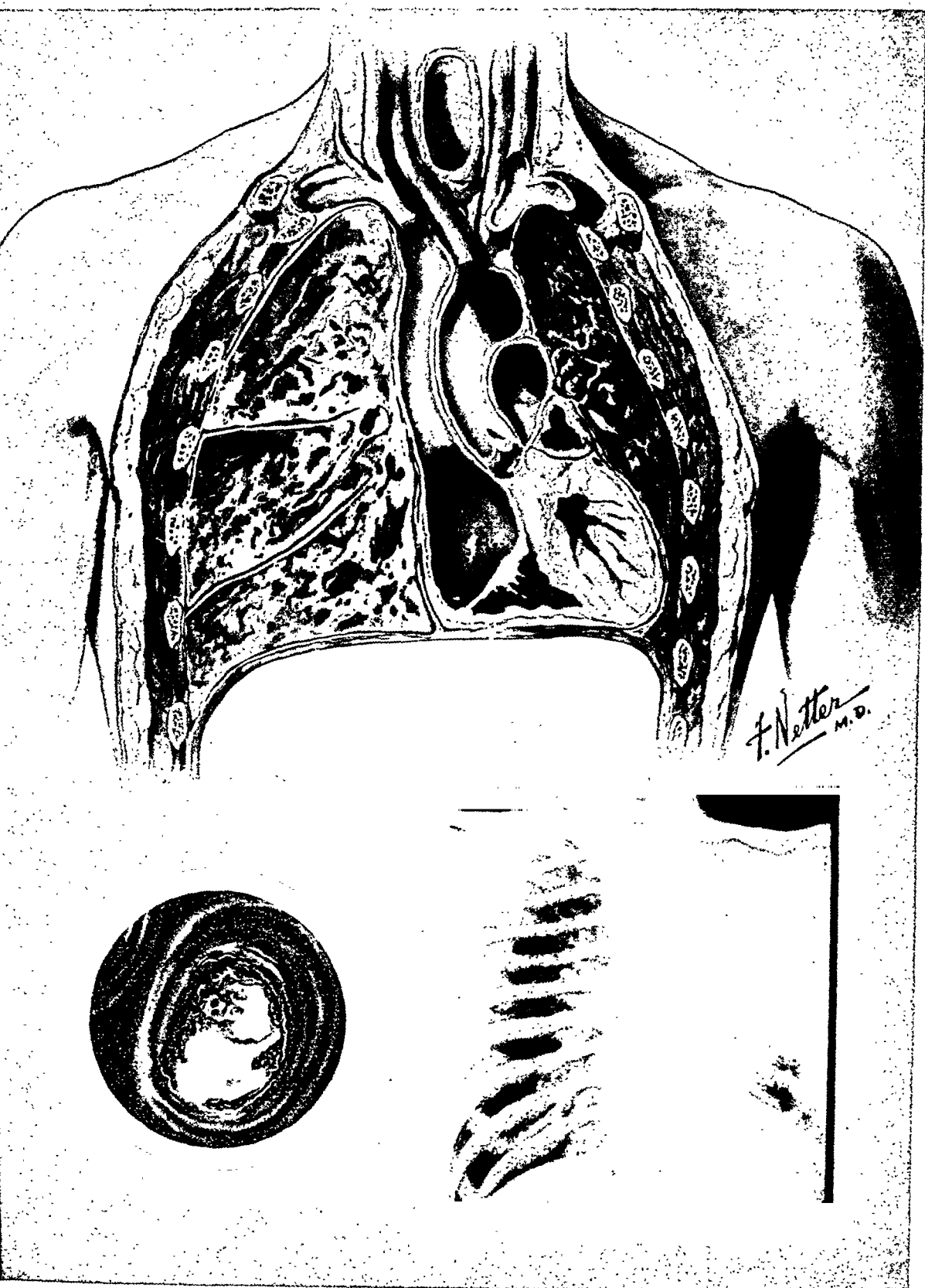
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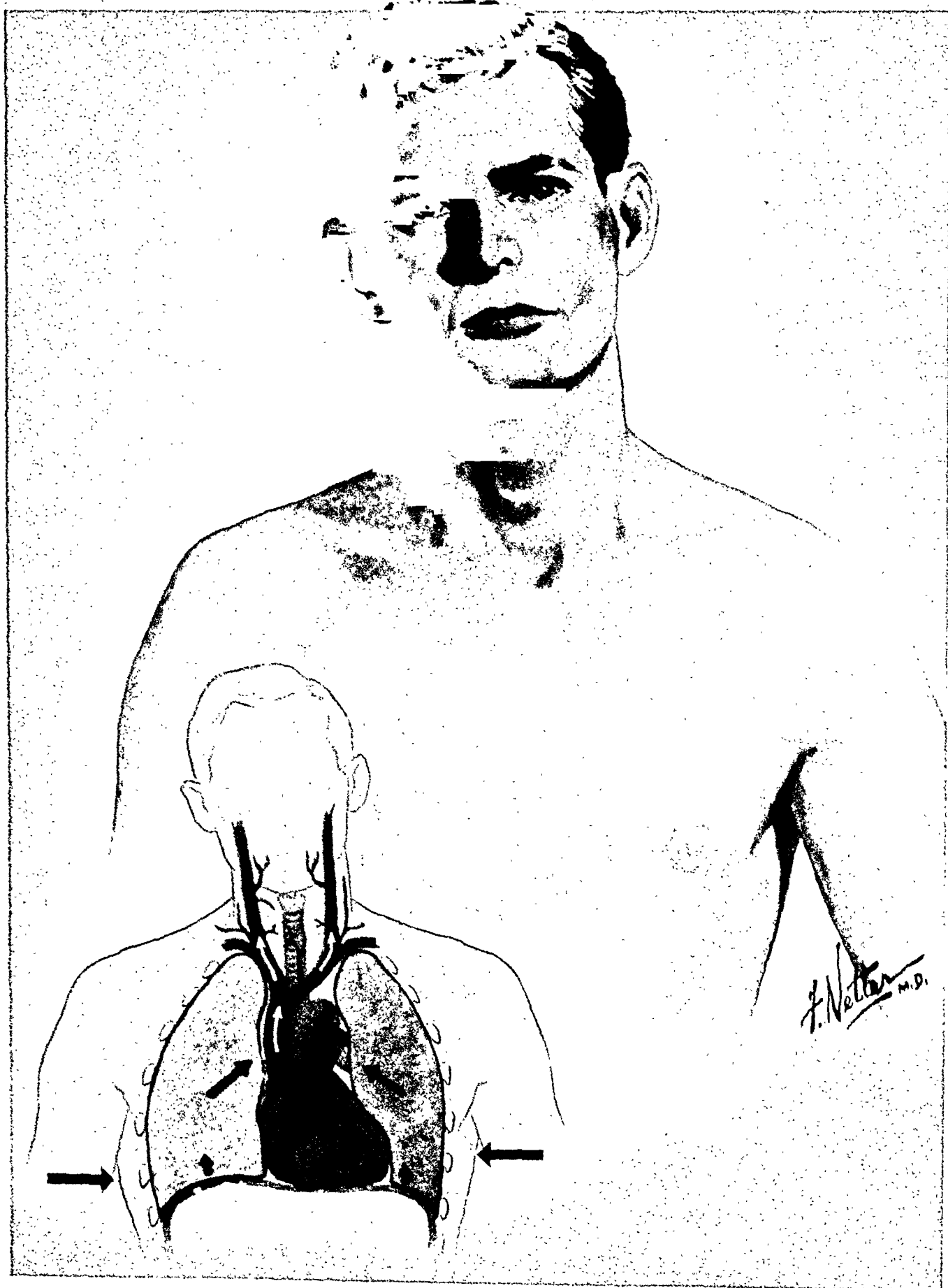
**Fig. 8—MASSIVE COLLAPSE (ATELECTASIS)**

Courtesy Ciba Pharmaceutical Products, Inc.



**Fig. 9—TRAUMATIC ASPHYXIA**

Courtesy Ciba Pharmaceutical Products, Inc.



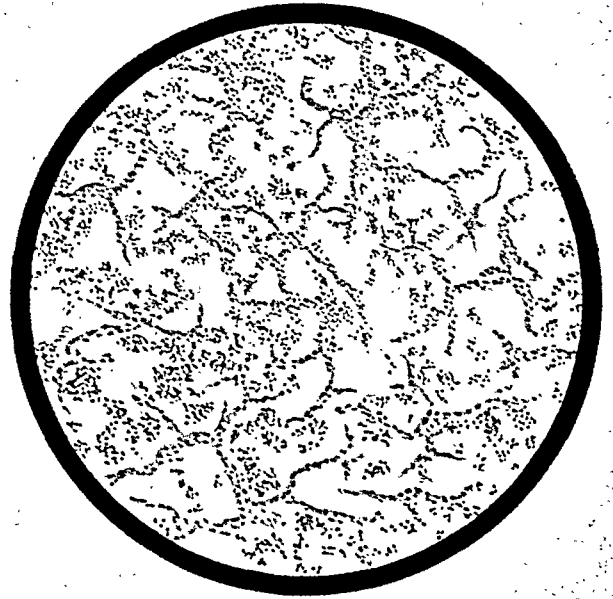
# Fig. 10—CHYLOTHORAX

Courtesy Ciba Pharmaceutical Products, Inc.

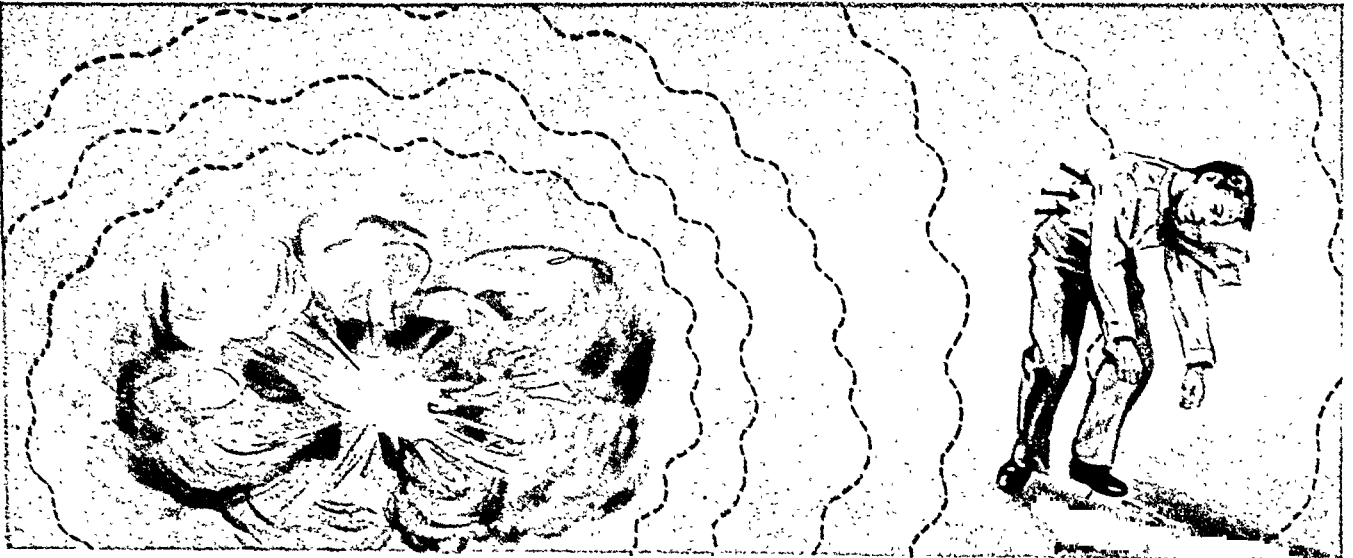


# Fig. 11—BLAST INJURY

Courtesy Ciba Pharmaceutical Products, Inc.

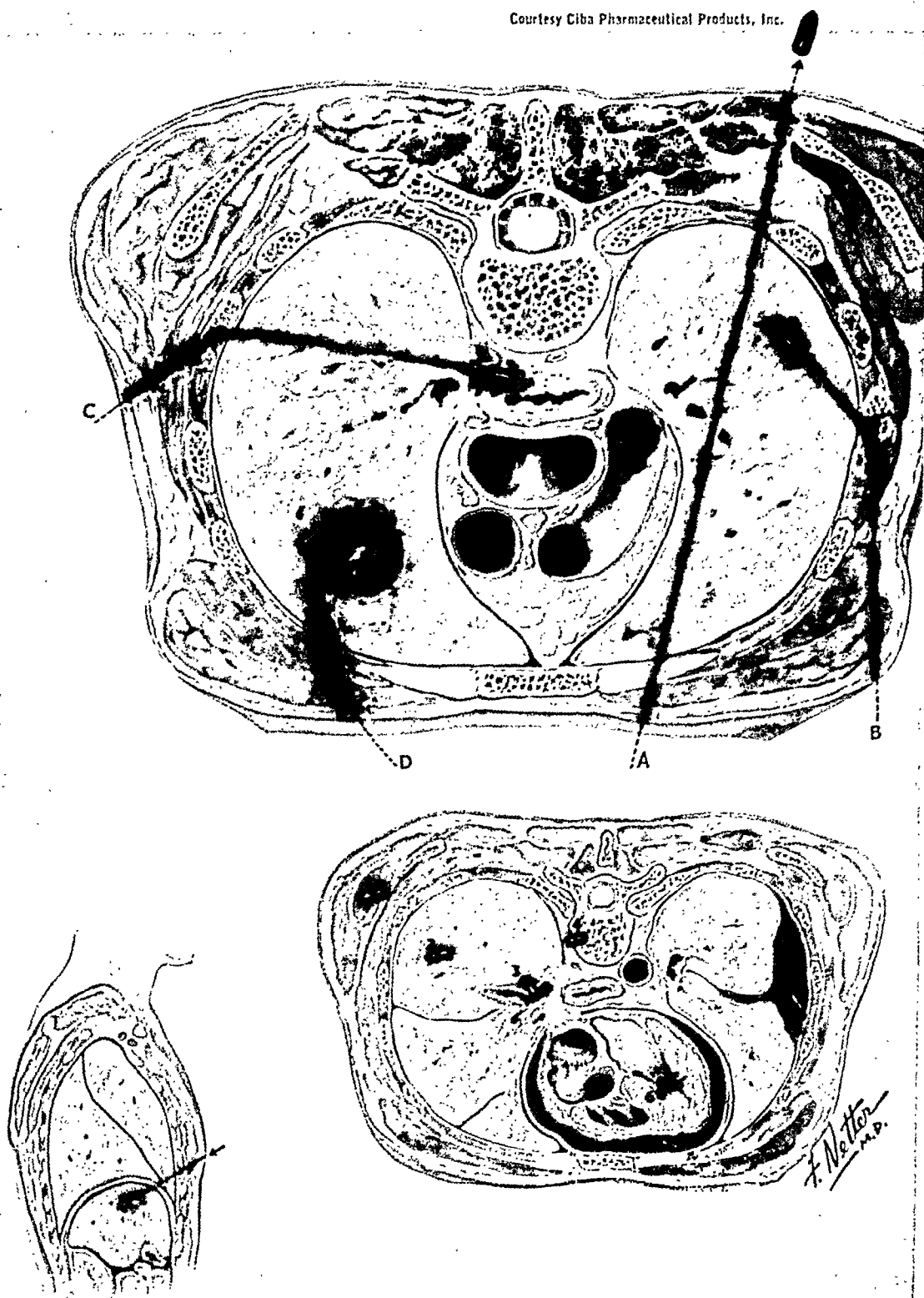


*F. Netter, M.D.*



# Fig. 12—GUNSHOT WOUNDS

Courtesy Ciba Pharmaceutical Products, Inc.



phere, but changes with inspiration and expiration. The intrapleural pressure is normally negative because of the elastic recoil force of the lungs. The two elastic lungs pull like evenly balanced springs on each side of the mediastinum. The lungs are held out against the chest wall in a state of tension by the negative pressure in the pleural sacs. If one pleural cavity is opened, the underlying lung is released and recoils toward its point of fixation at the hilus. The collapse of the lung is primary, and draws the air into the pleural cavity. The air does not rush in and compress the lung.<sup>114</sup> Formation of a pneumothorax upsets the balance of the lung pull on the mediastinum, and the heart is drawn toward the unaffected side by the undisturbed traction force.

*Treatment.* No active treatment is indicated other than rest and sedation as the air is absorbed by the pleura. Aspiration of air is rarely indicated. The semi-upright position will lessen the discomfort of the patient.

*Valvular, Tension or Pressure Pneumothorax.* This type contains air under an increasing positive pressure subsequent to a crushing injury or penetrating wound with a valve-like laceration of the lung or chest wall. Air is taken into the pleural cavity with each inspiration but cannot leave with expiration. The tissues surrounding the injured area act as a one-way valve and admit more air than can be expelled. Littlejohn<sup>97</sup> does not believe a valvular opening in the parietes produces a pressure pneumothorax.

In a tension pneumothorax the affected lung is collapsed and compressed against the mediastinum by the increasing positive pressure. The latter displaces the mediastinum toward the opposite side with encroachment upon the volume of the opposite lung. There is a downward displacement of the diaphragm on the involved side.

Disturbance of the circulation occurs more rapidly on the right side because of direct pressure on the great veins, and the right auricle limits the diastolic flow to

the heart. Clinical signs revealed are labored respirations, increasing dyspnea together with tympanitic note and shifting of the trachea, apex beat and mediastinum toward the unaffected side.

Tension pneumothorax unless artificially relieved will result in a fatality. As the syndrome progresses, a bulging of the intercostal space may be observed.

*Treatment.* Blades<sup>12</sup> advises simple aspiration of air, which may be performed in the second interspace about two inches from the sternum or about the sixth or seventh interspace in the posterior scapular line. Air under pressure escapes with a whistling sound. Simple aspiration of air or continuous aspiration under water drainage may be necessary. (Fig. 6.)

Intercostal thoracotomy with closed catheter drainage may be substituted in those cases in which air continues to escape under pressure. The catheter is removed as soon as air ceases to escape, usually twenty-four to forty-eight hours.

Thoracotomy is employed in those cases in which the tension pneumothorax recurs in spite of the aspiration. The pulmonary laceration emitting the air is sutured. Closure of the chest wall is effected by suturing the wound or by suturing the lung into the wound with institution of closed drainage. Some cases will require open operation with suture of the pulmonary laceration or closure of the parietal wounds.

*Open Pneumothorax.* The pleural cavity communicates with the exterior through a wound in the thoracic parietes. There is free entrance of air during inspiration and free exit of air during expiration. If the tear in the lung is on the mediastinal surface with involvement of the adjacent mediastinal pleura, emphysema will complicate the picture.

Open pneumothorax is frequently caused by tangential injuries. The patient presents cyanosis, respiratory distress and a hissing sound of air on inspiration and expiration, as the air enters and leaves the thorax through the wound. Blood and air are

sucked into and escape from the wound during respiratory movements.

The pleura is exposed to gross contamination and there is considerable loss of heat due to the excessive ventilation of the pleural cavity. The lung is thrown back and forth into the wound, and the mediastinum flaps back and forth (flutters). There is also a movement of air from the more collapsed lung during inspiration and in the reverse direction during expiration (pendulum air). If the pleural opening is larger than the tracheal opening, air will enter more freely through the wound than through the trachea. Since air drawn directly into the pleural cavity cannot reach the respiratory epithelium, it is useless and this will lead to progressive asphyxia. The mediastinum is forced toward the unopened side in inspiration and back toward the opened side in expiration. Mediastinal flutter subjects the heart and great vessels to varying degrees of positive and negative pressures, and interferes with the emptying of the large mediastinal veins and the filling of the right auricle. Lillienthal during the last World War found a mortality rate of 34 per cent, which was a larger death rate than in any other class of thoracic wounds.

*Treatment.* The emergency treatment (Fig. 6) of open chest wounds is, first to control the hemorrhage, then to re-establish the normal negative pressure relationship of the pleural cavities. An emergency occlusive dressing to plug the wound and steady the mediastinum is imperative.<sup>97</sup> Use of an occlusive dressing with waterproof material is desirable. The chest wall should be strapped. Littlejohn<sup>97</sup> urges suturing of sucking wounds rather than packing. If a tension pneumothorax develops, aspiration must be undertaken at once. Barrett advocates suturing the muscles over the defect but not the skin. Delayed primary suture can then be done at the base hospital.

The temporary emergency treatment is followed by open operation under positive pressure anesthesia, as soon as circum-

stances permit. This consists of wound débridement with removal of loose rib fragments and devitalized tissues. The pleural cavity is explored, accessible foreign bodies are removed and the wounds in the intrathoracic organs are repaired. The parietal defect is closed after obtaining full expansion of the lung. Airtight closure can be effected by the use of the diaphragm, muscles of the thoracic wall or suture of the lungs to the margins of the thoracic wall.<sup>63</sup> Closed drainage is instituted at the dependent portion of the pleural cavity away from the wound in the thoracic wall. The superficial portion of the wound is packed, following the local application of chemotherapy. The gauze used for packing is anchored to the skin margins to prevent retraction into the pleural cavity.

Open or tension pneumothorax precludes the use of airplane for transportation, unless high concentrations of oxygen inhalation are available.

#### EMPHYSEMA

*Subcutaneous emphysema* results from a laceration of the lung and parietal pleura allowing the air from the bronchial passages to escape into the subcutaneous tissues. (Fig. 7.) It may be caused by penetrating or non-penetrating trauma, more commonly as a result of laceration of the lung by missiles or rib fragments. A tearing of the lung at the site of a pleural adhesion, or subcutaneous rupture of the larynx or trachea may occasionally cause a subcutaneous emphysema.<sup>113</sup> This is recognized by the subcutaneous swelling and crepitation about the chest, axilla, face or in the other lax subcutaneous tissues.

*Treatment.* Air will absorb spontaneously under conservative therapy. Multiple needle punctures in the subcutaneous tissues or repair at the site of air leak is rarely indicated in this type.

*Mediastinal emphysema* is a result of a penetrating or crushing injury with a tear of the trachea, a large bronchus<sup>13, 28, 87, 109</sup> or of the esophagus, with escape of air into

the meshes of the mediastinum. This produces serious compression of the mediastinal structures with resultant dysphagia, cyanosis, extrapericardial tamponade, circulatory failure and death. It is recognized by the labored respirations, dyspnea, engorgement of the veins of the neck and upper extremities, and crepitation above the manubrium and lower part of the neck.

Air gradually passes upward through the superior thoracic aperture into the superficial tissues. The crepitant areas may extend into the subcutaneous tissues up to the upper extremities and neck<sup>35</sup> or down the chest wall.

*Treatment.* Transverse incision at the base of neck over the carotid sheath and use of suction drainage will decompress the mediastinum.<sup>29, 40, 57, 150</sup> Large wounds of the trachea, bronchus, and esophagus require surgical closure. Mediastinitis with abscess formation may be a late complication.

#### MASSIVE COLLAPSE (ATELECTASIS)

Massive collapse of the lung (Fig. 8) may follow either penetrating or non-penetrating chest injuries.<sup>58, 105, 112, 116</sup> The etiologic factor is the presence of a mucous plug, blood clot or foreign body in one or more bronchi. Crushing trauma often produces a reflex muscle spasm and fixation of the chest wall, and as a result of the loss of lung movement, mucous plugs or blood clots may fill a bronchus or several bronchi and produce a massive collapse of the lung. The collapse may be limited to a few lobules or involve an entire lobe, lung or opposite lung.<sup>159</sup> Occasionally, multiple small areas of atelectasis may occur following trauma.<sup>83</sup>

A sudden rise in temperature to 103°F., with increased pulse and respiratory rates are important clinical signs. The patient complains of dyspnea, which frequently is out of proportion to the degree of pulmonary involvement present. The presence of cyanosis will depend upon the amount of pulmonary tissue involved. Productive cough is present with mucopurulent or

bloody sputum. Another clinical type of atelectasis may result in collapse without chest symptoms or cardiorespiratory embarrassment.

There is restriction in respiratory excursion of the involved side and elevation of the diaphragm. The heart, trachea and other mediastinal structures are pulled toward the affected side and respiratory excursion of the affected side becomes diminished. Narrowing of the intercostal spaces may be visible. Percussion note ranges from dullness to flatness. The breath sounds are distant, absent or bronchial in character.

The shrinkage comes from the contraction of the elastic fibers of the lung and from the active absorption of the air from the alveoli by the blood vessels.<sup>16</sup> The rapid contraction of the lung implies the rapid production of a high negative pressure. The falling in of the chest wall and the rising of the diaphragm compensate for this but to a small extent; the mediastinum and heart are, therefore, drawn violently over to the affected side, while the opposite lung becomes distended and emphysematous.

Radiographs show increased density of the lung with a marked shift of the heart and structures of the mediastinum toward the affected side. There is an elevation of the diaphragm and a narrowing of the intercostal spaces.

*Treatment.* Simple measures, such as postural drainage with elevation of the foot of the bed, rolling the patient on the uninvolved side and inciting the cough reflex should be tried. Thumping of the chest wall to dislodge the occluding plug may be of value.

Bronchoscopic removal of the plug<sup>132</sup> will allow normal aeration of the involved lobe or lobes and restoration of the normal physiological interchange of gases within the alveoli. The inhalation of 5 or 10 per cent carbon dioxide and oxygen mixture at hourly intervals will often help expand the lung or the lobe that has been collapsed.



## TRAUMATIC ASPHYXIA

Crushing injuries of the chest wall cause compression of the thorax and may be followed by two definite clinical types of asphyxia.<sup>17,78,92</sup> (Fig. 9.)

Laird and Borman<sup>94</sup> contend that among the factors responsible for the morbidity of this condition are the occurrences of panic in large crowds, the collapse of structures seating or housing large groups of people, human negligence, our desire for speed, and the consequent use of machinery in industry and vehicles for rapid transportation.

1. *Pale Type.* In this type the respiratory movements are superficial, irregular and uneven.<sup>47</sup> There is a pallor of the face or neck with areas of purplish discoloration. The pulse is weak, rapid and thready. The skin is cold and clammy.

2. *Ecchymotic Type.* DeBailey<sup>37</sup> describes this condition as a violet blue discoloration of the face, neck and occasionally the upper chest and shoulders are involved. The bluish or purplish discoloration is strictly limited to the distribution of the valveless veins of the head and neck. In this area multiple petechial hemorrhage and stasis of blood in the tiny skin vessels is observed. The buccal and pharyngeal mucous membranes show similar minute ecchymotic or petechial hemorrhagic spots. Hemorrhage into the subconjunctival tissues with protrusion of the eyes and swelling of the lids and tongue usually adds to this terrifying picture. There may be coma from intracranial hemorrhage or blindness from choked disk.

Wise<sup>170</sup> aptly states that extravasation into the subconjunctival tissues with protrusion of the eyes and swelling of the lids presents a never to be forgotten picture.

The sudden rise in intrapleural pressure causes a collapse of the mediastinal veins. The blood is forced back from the right heart and great thoracic veins into the valveless veins of the neck and face.

There may be associated lesions, as fractures of ribs or other bones, cerebral

congestion,<sup>133</sup> intrathoracic hemorrhages,<sup>121</sup> and intra-abdominal laceration or hemorrhagic infiltration of the viscera.<sup>78</sup>

*Treatment.* Sedation, oxygen therapy, respiratory stimulants and supportive treatment may be necessary. Associated injury as ruptured diaphragm or abdominal viscera must be ruled out. Prognosis is good with a recovery period of seven to twenty days.

## CHYLOTHORAX

*Anatomy of the Thoracic Duct.* The thoracic duct (Fig. 10) originates in the cisterna chyli at the level of the first and second lumbar vertebrae to the right of the aorta. It traverses the aortic opening of the diaphragm and ascends through the posterior mediastinum between the aorta and azygos vein, to the level of the fifth thoracic vertebra, where it crosses to the left side of the aorta. It then ascends through the superior mediastinum to the root of the neck where it turns laterally and then forward to empty into the left subclavian vein or innominate vein at its junction with the internal jugular vein.

*Injuries to the Thoracic Duct.* Although uncommon, duct injuries<sup>102</sup> may result from indirect violence.<sup>5,6,25,59,106,145,154,162</sup> Trauma to the thoracic duct more frequently results in a chylous effusion into the right pleural cavity as the duct is situated on the right side for two-thirds of its thoracic course.

The thoracic duct may be indirectly injured by sudden and exaggerated hyperextension of the thoracic spine. Tearing of the duct is more likely to occur immediately after a heavy meal, when the duct is distended with chyle. It may be directly injured by gunshot, shrapnel or stab wounds. The primary trauma usually overshadows the findings of thoracic duct damage. There is a latent period of about four days before the evidence of duct damage makes its appearance. The early picture is one of effusion into the pleural cavity, followed by inanition and exhaustion.

Radiographs of this condition show a picture similar to that of hemothorax. The aspirated fluid is a milky, non-coagulable opalescent substance containing fat<sup>39</sup> and may be easily mistaken for pus. This fluid is alkaline in reaction, has a specific gravity of 1012 or higher and settles into an upper milky layer and a lower bloody layer.

The prognosis is poor; death generally ensues from inanition and exhaustion.

*Treatment.* The treatment is surgical repair of the duct, but the operation is extremely difficult and the outcome doubtful. Conservative measures consist of repeatedly aspirating the chyle from the pleural cavity and replacing it into the blood stream by intravenous injection.<sup>5, 149, 164</sup>

#### BLAST INJURY

Concussion of the lung as related to detonation of high explosives was observed in World War I. The British have carefully studied this condition which they call "blast injury." (Fig. 11.) Similar forms of thoracic injuries were observed in the recent Spanish Civil War.<sup>92, 147</sup>

Blast injury<sup>26, 50, 64, 93, 122, 123, 134, 135, 155, 169, 174</sup> is a distinct clinical entity which follows severe, non-penetrating chest injuries with clinical manifestations varying from a slight degree of respiratory distress to a complete cessation of respiration. There is generally no injury to the chest wall. Eloesser<sup>48</sup> states that this entity may be combined with traumatic asphyxia.

The lung injury is due to the detonation of high explosives,<sup>90</sup> therefore, all people rescued from the vicinity of an exploding bomb must be suspected of having a lung blast injury. Zuckerman<sup>175</sup> in a recent investigation on experimental animals has shown that these effects are produced by the compression wave of air upon the chest wall and that the protection of the chest wall prevents damage to the underlying lungs.

The mechanism of this condition is not yet satisfactorily explained. It has been

suggested that the blast wave set up in the surrounding air may cause sudden distention of the lungs by acting through the respiratory passages or that the succeeding suction wave may lower the alveolar pressure with consequent rupture of the alveolar capillaries.

*Theories.* Some of the theories are: (1) Lesions are due to a lowering of alveolar pressure by the suction wave, acting through the respiratory passage with consequent rupture of the alveolar capillaries; (2) lesions caused by distention of the lungs with air, and (3) lung lesions are due to the impact of pressure wave on the chest wall.<sup>81</sup>

The experimental work of Zuckerman<sup>174, 175</sup> appears to prove that the lesions are probably due to impact of the pressure wave on the chest wall. He has shown that when a rabbit's chest wall is enclosed in a rubber sponge jacket there was no pulmonary damage, after exposure to blast; whereas if one side of the chest was protected and the other side unprotected, the unprotected side showed evidence of blast injury.

*Gross Aspect.* The lungs show general congestion and extensive deep parenchymal hemorrhage, which may extend to the surface and produce what appear to be subpleural hemorrhages.

*Microscopic Aspect.* Alveolar walls and capillaries are disrupted. The alveoli and bronchioles are filled with blood. Some effusion is present throughout the interstitial lung tissue.

Patients suffering from blast may show little or no evidence of injury other than a slight bloody froth from the mouth. Damage to other viscera may be co-existent. The most common finding is expectoration of frothy, blood-stained sputum. There may be varying degrees of shock, cyanosis and dyspnea. Pneumonic consolidation may be a late complication.<sup>64, 122</sup>

As a rule there are no fractures or external signs of injury. Such findings are fairly common in children, due to the elastic nature of the thoracic cage, resulting

in compression of the lungs between the resilient ribs. It is unlikely that the pulmonary damage is responsible for either sudden death or later fatalities except as a contributory factor. Stewart suggests that a cerebral lesion may result from the sudden hydraulic compression on the central nervous system in its firm encasement, resulting from sudden compression of the thoracic cage with violent back pressure on the venous side.

*Prevention.* Blast injury may be prevented by the use of a protective jacket about the chest wall or use of air raid shelters or trenches preventing the blast wave from contacting the body wall.

*Therapeutic Treatment.* The treatment is symptomatic and supportive. Complete rest and oxygen inhalation should be instituted.<sup>169</sup> Chemotherapy may be used for its bacteriostatic action.<sup>134</sup>

#### THORACIC WOUNDS

The increasing use of explosive missiles has created a rise in the incidence and severity of thoracic wounds. Penetrating and perforating explosive wounds result in greater cardiorespiratory disturbance and tissue damage. These pathological factors plus the retention of foreign bodies enhance the predisposition to infection.

Gunshot wounds (Fig. 12) sustained by civilians are usually from plain or jacketed bullets. In warfare, on the other hand, penetration and perforation is more apt to be caused by machine gun bullets or shell fragments.<sup>66</sup>

In civil life, chest wounds are mostly of the stab or closed penetrating type in which extensive tissue injury, disturbance in cardiorespiratory physiology, and the development of infection are minimal. For these reasons chest wounds occurring in civil life are more readily adaptable to conservative management.<sup>37</sup> On the other hand, in penetrating war wounds of the chest, operative intervention is more frequently indicated.<sup>62,78,99,171</sup>

Examination for signs of air or fluid in the pleural cavity, and frequent determina-

tions of the temperature, pulse rate, blood pressure, and the apex beat of the heart are important. Roentgenographic studies will reveal retained foreign bodies, mediastinal displacement, pneumothorax, and collapse of the lungs.

Early operation was advocated by Duval<sup>11</sup> and Gask<sup>26</sup> and substantiated by more recent contributors.<sup>20,92,110,117,132,156,157</sup>

Walker<sup>163</sup> states that 60 per cent of the war casualties are accounted for by gunshot wounds of the chest, and it is stated that 40 per cent of the deaths in the field are due to such injuries.<sup>80</sup> A large number of soldiers in the front lines are killed by small fragments of grenade or shell piercing the front of the chest, with resultant tearing of the heart or the roots of the great blood vessels, and causing almost instantaneous death.

There is a high mortality rate as a result of penetrating wounds of the chest. It is difficult to obtain complete records from the battlefield, as many men with gunshot wounds die immediately.

Sauerbruch, in 1914, counted 300 dead soldiers on a battlefield and found that 122 (37 per cent) had gunshot wounds of the chest. In the American Army during the first World War,<sup>107</sup> there were 174,296 admissions resulting from battle injuries. Among this number, the thoracic region was involved in 4,595 cases, being preceded in frequency by involvement only by the limbs, the head and face. While the total mortality was 7.73 per cent, that of the chest wounds was 24.05 per cent.

Trueta<sup>160</sup> found that of 9,850 patients treated in different hospitals in Barcelona, 12.1 per cent had thoracic injuries, an incidence second only to that of injuries of the limbs.

Ryle<sup>138</sup> studied a series of 130 cases of penetrating wounds of the chest in 1917, the total mortality being 23 per cent. In approximately 60 per cent of the cases there was no indication for surgical intervention.

In the Sino-Japanese War, Ranson<sup>128</sup> found one wound in every twelve was of the thorax. Some observers have given

figures well over 33 per cent of the total killed.<sup>50</sup> Hardt and Seed<sup>66</sup> in a series of 280 cases found in the fatal cases that the vast majority of entrance wounds were inflicted on the left side of the anterior aspect of the chest, while in the non-fatal cases the path of the projectile rarely involved the mediastinum. Boland<sup>15</sup> in a series of 1,009 cases at the Grady Hospital in Atlanta found 85 per cent of chest wounds were penetrating and 15 per cent were non-penetrating. Of the former 75 per cent were stab wounds and 21 per cent were gunshot wounds. Infection occurred in less than 20 per cent of the cases. Elkins<sup>47</sup> in a series of 553 cases found infection in 1.04 per cent of the injuries. Yates<sup>171</sup> states that 80 per cent of chest injuries in warfare are comprised of penetrating wounds associated with visceral damage.

The end result will depend upon many factors, as the type and location of the missile, the geographic site of the battlefield and the speed with which first aid treatment is rendered and the patient removed to the base hospital.<sup>65</sup>

The course of a missile is unpredictable. A missile traversing the upper chest wall will pass through thick muscle layers which tend to close in the track and prevent communication of the pleural sac with the atmospheric air, thereby converting it into a closed chest wound.<sup>144</sup> The lower chest has no such protective covering and large wounds will tear the pleural cavity, producing a sucking wound.

Subcutaneous emphysema is a fairly common finding in penetrating wounds, either from air sucked in through the wound, or more often from air extravasated from the pleural cavity of the lungs.

A bullet may produce a small point-like entrance wound because of its size and high velocity. Explosive missiles are irregular and jagged, they acquire a tremendous spin and drag foreign material and clothing into the wound.

The points of entry and exit do not always indicate that a missile has taken a straight course between these two sites.

The size of the entry wound is no criterion of internal hemorrhage. In the Spanish Civil War, minute punctures from small fragments of bombs utterly belied the extent of internal damage and bleeding.<sup>143</sup>

*Types of Wounds.* 1. Small entrance with no exit wounds (penetrating) are frequently encountered in civil life and are usually caused by plain or jacketed bullets.

2. Small entrance and small exit wounds (perforating<sup>127</sup>) suggest a bullet of high velocity passing through an intercostal space on both sides of the chest. Its long and narrow path is marked by a coagulated and scarred trail.<sup>52</sup> The small exit wound suggests that no bone has been encountered by the missile.

*Treatment.* Small perforating wounds without any symptoms simply require a sterile dressing over the entrance and exit wounds.<sup>41,62,161</sup> Small bullets may be allowed to remain in the thorax unless in the vicinity of vital structures. The lung tolerates foreign bodies better than the pleura. The optimum time for operation for removal of a foreign body is probably in the second week.<sup>4</sup>

3. Small entrance and large exit wounds (perforating) suggest rib injury close to the exit wound. The shattered bone reduces the velocity of the bullet, thereby increasing the damage to the soft tissues and producing a more extensive wound track. The exit wound may show jagged laceration with spicules of bones or macerated muscle tissue. The bullet may ricochet or be deflected so as to remain within the body at a different level.

*Treatment.* Débridement of the exit wound should be performed as mentioned under the treatment of compound fractures. Thoracotomy is indicated for persistent signs of bleeding into the pleural cavity, indriven bony fragments and large retained missiles or high explosive fragments.

4. Large entrance wounds with no exit wounds (penetrating) indicate injury due to explosive missiles. Shrapnel wounds are usually multiple and cause irregular jagged wounds. Because of the irregularity and

sharp points of the shrapnel, it almost always carries clothing with it into the wound.

*Treatment.* These wounds are usually grave. Single large entrance wounds require the same treatment as is discussed under open pneumothorax.

5. Large entrance and large exit wounds are usually fatal. Those patients remaining alive will require treatment as outlined under open pneumothorax.

Bullet wounds usually heal without infection if no clothing or other foreign material is carried into the wound. All patients with gunshot and explosive wounds will require antitetanus and antigas therapy as well as chemotherapy.

#### DIAPHRAGMATIC INJURIES

The diaphragm may rupture as a result of crushing injuries of the thorax or abdomen or be injured by penetrating missiles.

Diaphragmatic lesions occur more commonly in the sloping muscular portion where it lies in contact with the thoracic wall. The posterior portion of the left side is more frequently involved than the right side.<sup>75</sup> Occasionally, bilateral involvement of the diaphragm may occur.<sup>108</sup> Small wounds may heal, others are plugged temporarily by omentum, spleen, etc. Wounds of the central tendinous part are more serious than those at the periphery. Wounds that traverse the diaphragm from below upward are more grave than the other type. Pain is induced by lifting, coughing and deep respiration. The diaphragm is motionless on the affected side. Hyperresonant percussion note may be present at the left base with absent or diminished breath sounds.

*Treatment.* Surgical repair is effected as soon as the patient's condition will permit. The subdiaphragmatic space is carefully explored for injuries to the structures in the area. The diaphragm is repaired with interrupted silk or linen thread following excision of the edges of the laceration.<sup>70, 103, 142, 151, 165</sup> Repair is performed

through the thoracic or abdominal approaches depending upon the type of wound and extent of the thoracic or abdominal damage.

The phrenic nerve is crushed to rest the diaphragm if the transpleural approach is used.<sup>49, 68, 75</sup> This is facilitated by resection of the ninth and tenth ribs.

Exploration of the abdominal cavity is aided by deflation of the stomach by means of a Levine tube. Harrington reported 210 cases of diaphragmatic hernia including thirty-six of traumatic origin with a total operative mortality of 4.3 per cent.<sup>69</sup>

In the non-penetrating type the most common immediate symptoms are shock, pain, dyspnea, upper abdominal tenderness, rigidity and pain referred to the neck and shoulders.

The penetrating type shows additional associated intrathoracic injury as pneumothorax, hemothorax, etc. The later symptoms will depend upon the size and position of the opening and consequent interference with cardiorespiratory and gastrointestinal functions. These injuries may be easily overlooked and present later symptomatology with difficulty in establishing a diagnosis (75).

#### ABDOMINOTHORACIC WOUNDS

The abdomen is telescoped into the thoracic cage, thereby producing abdominothoracic wounds when bullets or projectiles penetrate the chest wall transversely or anteroposteriorly within the limits of the broad belt that extends posteriorly from the ninth intervertebral cartilage to the lower border of the twelfth rib and laterally from the fifth to the twelfth rib.

The upper limit of the abdominal cavity reaches the level of the upper border of the fifth rib anteriorly on the right side and the fifth intercostal space anteriorly on the left side. The lower limits of the pleura are usually the lower border of the ninth rib in the mid-axillary line and the twelfth rib posteriorly.

Penetrating wounds of the trunk passing between the ninth intervertebral disc and the twelfth thoracic vertebra are likely to involve both thoracic and abdominal cavities.

The chest and abdomen may be penetrated by separate missiles or missiles may pierce the chest and emerge through the abdominal wall to be retained within the abdomen or vice versa.<sup>44,60,97</sup>

Missiles which traverse the diaphragm from below upward produce more grave injuries than those which occur from missiles traversing above downward.

Crushing injuries may result in thoracic-abdominal lesions with rupture of the liver or spleen.<sup>32</sup>

The clinical manifestations are variable and depend upon the extent and type of visceral involvement. Thoracic findings will co-exist with abdominal tenderness and rigidity of the upper abdominal wall. This must be differentiated from pseudoperitoneal reactions which occur in lower thoracic injuries. Gordon-Taylor<sup>60</sup> states that the abdominal rigidity is more likely to be unilateral and intermittent in thoracic injuries.

The blood pressure in the pulmonary circulation is about one-sixth that of the abdominal circulation, a fact which renders bleeding in the lungs more easily controlled than in the abdomen.

Abdominal signs and symptoms in the presence of a chest injury are not always indicative of an intra-abdominal lesion.<sup>148</sup> Injuries to the intercostal nerves or non-penetrating wounds of the diaphragm may cause abdominal pain, tenderness and muscular rigidity.<sup>122</sup>

Intrathoracic wounds may also produce retroperitoneal injuries of the duodenum, pancreas and kidneys.

Edwards<sup>44</sup> observes that "abdomino-thoracic" wounds are associated with a high mortality. Loria<sup>101</sup> quotes a 62.28 per cent mortality rate in a series of 228 cases. Gordon-Taylor<sup>60</sup> gives the recovery rate of abdomino-thoracic wounds in 1916 as about 18 per cent. In the present war in a

series of over 600 operations for abdominal injuries, he found penetrating abdomino-thoracic injuries to constitute about 13 per cent of the abdominal injuries. The recovery rate was 63 per cent. Seventy per cent of the patients with abdominothoracic wounds of the right side recovered; only 50 per cent of those with involvement of the left side survived. No patient with abdominothoracic injury implicating the hepatic flexure of the colon survived in his series.

In the Spanish Civil War these wounds comprised 11 per cent of all abdominal wounds.<sup>85</sup>

*Treatment.* Surgeons have variously advocated opening of the chest or abdomen first.<sup>3</sup> Bailey<sup>4</sup> advises emergency treatment of the chest injury, primarily because of the narrow margin of safety from sudden derangement of the normal thoracic visceral relationships. The transpleural route has the advantage of immediately equalizing the pressure in the thoracic and abdominal cavities and thus making reduction of the prolapsed abdominal viscera easier.<sup>27,63</sup> It also permits access to the phrenic nerve, which should be lightly crushed to facilitate the repair of the diaphragm.<sup>153</sup>

When the thoracic hemorrhage has been controlled, respiratory balance regained and the patient recovered from shock, exploration of the abdominal injury may be undertaken.<sup>26</sup>

Gordon-Taylor<sup>60,61</sup> summarizes the present day treatment of penetrating abdominothoracic injuries as follows:

"Through and through abdomino-thoracic wounds of the right side require no active surgical treatment provided there is no involvement of the thoracic or abdominal wall or peritoneal cavity. Accessible fragments lodged in the lung should be removed.

"In open pneumothorax, the chest assumes chronological priority of treatment.

"If the position of the wound of entry and exit in an abdomino-thoracic wound involves the left subphrenic area of the abdomen, the thorax should be dealt with

first and access to the upper abdomen obtained through the diaphragm.

"When the thoracic injury appears insignificant, but there is evidence of intraperitoneal damage, the abdomen is explored through a laparotomy incision.

"When the thoracic injury is slight and a through and through wound suggests an extraperitoneal course of a small fragment, such injury may be left alone.

"If an abdomino-thoracic injury has been approached from the abdominal aspect, it is important not to waste time trying to complete a difficult suture of the diaphragm in a critically ill patient, unless the aperture in the midriff is so large that immediate or early herniation of the abdominal contents is certain to occur."

#### ANESTHESIA IN THORACIC WAR WOUNDS

There is considerable diversity of opinion regarding the choice of anesthesia in these cases.<sup>3</sup> The most important factors are complete control of intrapulmonic pressure, adequate facilities for aspiration of secretions in the respiratory passages during the operation, the maintenance of quiet respirations and high oxygenation, the avoidance of distressing cough reflex, and the rapid return to consciousness following completion of the operation.<sup>120</sup> Differential pressure anesthesia is essential for accurate appraisal of the injury.

Procaine block of the intercostal nerves and subpleural perihilar infiltration blocks the cough reflex but has the disadvantage that few patients escape without considerable shock and pain.<sup>127</sup>

Halton<sup>65</sup> considers intratracheal insufflation the method of choice in either immediate or delayed procedures with the use of ether or chloroform.

Westell<sup>167</sup> prefers intravenous anesthesia combined with endotracheal insufflation of oxygen under pressure, supplemented by nitrous oxide if necessary.

Nosworthy<sup>118</sup> claims he has seen no ill effects arise from the use of sodium pentothal in patients who are "blue" from the previous administration of one of the

sulfonamide group of drugs. In view of its marked respiratory depressant action, its use may be contraindicated on other grounds and in no instance has he injected more than  $\frac{1}{2}$  Gm.

Crafoord<sup>31</sup> points out that controlled automatized respiration under anesthesia gives absolute rest to all the respiratory muscles and a quieter operative field than any other method. The importance of mechanically automatized breathing with rhythmic insufflation during the inspiratory phase and free outflow of gas during the expiratory phase during open chest operations is stressed.

Beecher<sup>7,8</sup> believes the anesthetist who is familiar with the problems of anesthesia for thoracic surgery can make it possible for the thoracic surgeon to proceed with deliberation in exploring thoracic wounds of warfare. It is the anesthetist who makes it possible for the surgeon to exercise the deliberation necessary for the proper control of hemorrhage, proper débridement of the wound, and to determine carefully what shall be done at once and what postponed. It is the anesthetist who makes it possible for the surgeon with only a general training to work with success in this field.

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# TRAUMATIC RUPTURE OF THE GASTROINTESTINAL TRACT BY NON-PENETRATING FORCES\*

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**T**RAUMATIC rupture of the gastrointestinal tract is a dramatic catastrophe which usually has a fatal termination. The appalling mortality is due not to our inability to repair the damaged bowel but rather to our ineptitude in arriving at an accurate diagnosis during the curative phase. All too frequently the provocative accident seems so trivial that it fails to focus attention on the injured viscera or the accompanying shock may be so severe that it completely masks the perforative syndrome. It is not until a fulminating peritonitis develops that a true evaluation is made.

## MECHANISM

Subparietal ruptures of the gastrointestinal tract are produced by traumatic forces which operate through an intact abdominal wall. While the destructive forces may be classified as crushing, tearing, and bursting, the actual damage is generally produced by a combination of these three agents. Usually the traumatizing force is of such violence that it not only overcomes the resistance of the abdominal wall but also macerates the bowel against such unyielding structures as the vertebrae and pelvic bones. Occasionally, indirect trauma, such as jumping down from an embankment or falling from a scaffold, may cause the jejunum and ileum to jerk so violently on their ligamentous and mesenteric attachments that the bowel is torn. Falling on an overdistended stomach has produced a bursting rupture of this viscus.<sup>4</sup> Lacerations of the mesentery may precipitate an acute intra-abdominal hemorrhage or initiate a segmental gangrene of the bowel. The ileum, jejunum, duodenum

and stomach are affected in the order mentioned.

Subparietal ruptures of intestines which become incarcerated in hernial sacs occur so frequently as to necessitate special mention. Wilensky and Kaufman<sup>5</sup> collected forty-three instances in which indirect muscular trauma of the herniated bowel resulted in perforative lesions. Sometimes the provocative insult was most trivial, such as, sneezing, coughing, lifting a barrel, stumbling, urinating, defecating, pressure from an ill-fitting truss, attempted manual reductions and wrestling.

## SYMPTOMS

Traumatic rupture of the intestinal tract within a closed abdomen produces no pathognomonic syndrome but can and does mimic every other type of abdominal emergency.

The majority of patients are first seen in the state of primary shock which may be so pronounced that it successfully masks the perforative syndrome. Hypothermia, hypotension, sweating, and a weak ineffective tachycardia signifies the shocked state. These symptoms are usually transient unless aggravated by extensive internal hemorrhage or damage to the visceral and skeletal systems. When the patient rallies from the shock he usually complains of a dull aching pain confined to the zone of trauma. Nausea, vomiting, hyperthermia, and septic reactions announce the onset of a peritonitis.

Intra-abdominal hemorrhage frequently complicates the clinical picture. Lacerations of the mesentery and contusive ruptures of the liver, spleen, pancreas and kidneys may precipitate such a rapid

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exsanguination that the patient succumbs at the scene of the accident. Hematemesis and melena indicate injury to the bowel

posture is suggestive of a retroperitoneal hematoma.

One must always be alert for the symp-

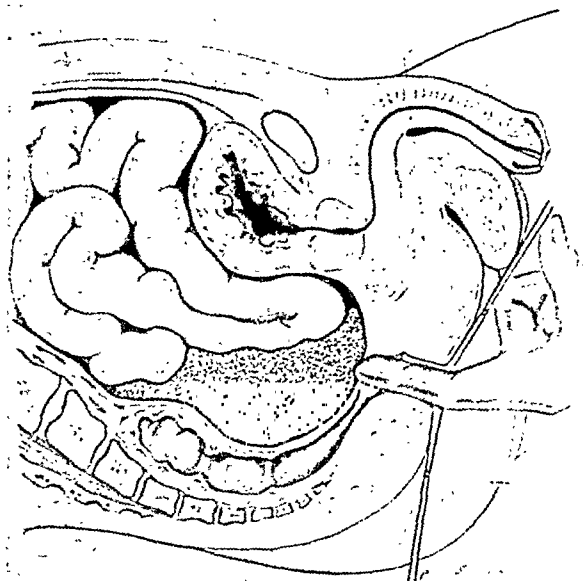


FIG. 1. Blood and visceral fluids tend to collect in the rectovesical space. They form a soft fluctuant mass which can be detected by rectal examination.

wall. It is imperative that determinations of the pulse rate, changes in blood pressure and leucocytic responses be made frequently in order to evaluate the severity of the hemorrhage.

The physical examination is usually very informative but it may reveal so few findings that both the surgeon and the patient are lulled into a sense of false security. One must remember that the shocked patient does not make a normal response to peritoneal irritations. Localized abdominal tenderness, regional muscular rigidity, tympanities, and a leucocytic increase are the most valuable signs. Occasionally a soft, fluctuant mass can be palpated in the rectovesical space indicating the presence of blood or visceral fluids (Fig. 1), the nature of which can be determined by colposcopic aspirations. In one such instance bile-stained pus was recovered, thus confirming the impression of a ruptured jejunum, and on another occasion frank blood confirmed the diagnosis of an internal hemorrhage. A percussion dullness which does not shift with a change of

toms of a delayed perforation for in 60 per cent of our cases it required from twelve hours to ten days for the actual soiling of the peritoneum to occur. A paralytic ileus may permit a small perforation to become "walled-off" and it is not until the return of active peristalsis that the intestinal contents are forced through the rent.<sup>4</sup> Partial devitalization of the bowel wall, either from contusions or impairment of its blood supply, may result in a slow but progressive ulcerative necrosis which requires several days to erode through the bowel wall.<sup>5</sup> A rising leucocytosis, blood in the feces, and signs of an acute condition of the abdomen are the warning signals of an impending perforation. Purgatives, enemas, and solid foods should be restricted until the period of doubt has passed.

Roentgenograms are particularly informative if one suspects a rupture of the gastrointestinal tract for a pneumoperitoneum is pathognomonic of this condition. Bedside films can be taken while the patient is being treated for the primary shock. Whenever possible the exposure should

be made with the patient in the upright position as this compels the liberated gas to collect beneath the diaphragm. Failure to visualize a "bubble of gas" is no assurance that the intestinal tract is intact as it merely signifies that the gas has not escaped into the peritoneal cavity.<sup>3</sup> A positive diagnosis means much but a negative one has no value. If one suspects a perforative lesion, repeated x-rays should be taken every two hours until a correct evaluation has been reached.

Roentgenograms also reveal the presence of an intestinal obstruction by outlining the dilated bowel. Regional accumulations of blood or other fluids may produce incriminating shadows. Dislocations and fractures of the vertebrae, pelvic bones and skull are quickly detected. These complications may play either a minor or major rôle in this traumatic drama but it is essential that all contributing factors are recognized and properly treated.

The differentiation between a perforative lesion and a traumatic peritonism is a tantalizing problem.<sup>2</sup> In the former immediate correction is imperative while in the latter passive conservatism is indicated. Peritonism or neuroperitoneal shock represents the irritative responses of the sympathetic nervous system to the initial trauma. It is particularly prone to occur in severe injuries to the skeletal system. Fortunately, the urgent symptoms of peritonism subside while the patient is being treated for the primary shock. If they persist in spite of energetic therapy, surgical exploration is in order. Careful observation during this early period is essential and affords the only basis for a correct appraisal.

#### TREATMENT

Counsellor and McCormack<sup>1</sup> studied 1,313 cases of subparietal ruptures of the intestines as reported in the literature and concluded that they were strictly surgical problems. The mortality in the non-operative group was 100 per cent as compared to 60 per cent for those receiving surgical therapy.

Active treatment consists of two phases: that of combating the primary shock and that of correcting existing defects. Coun-

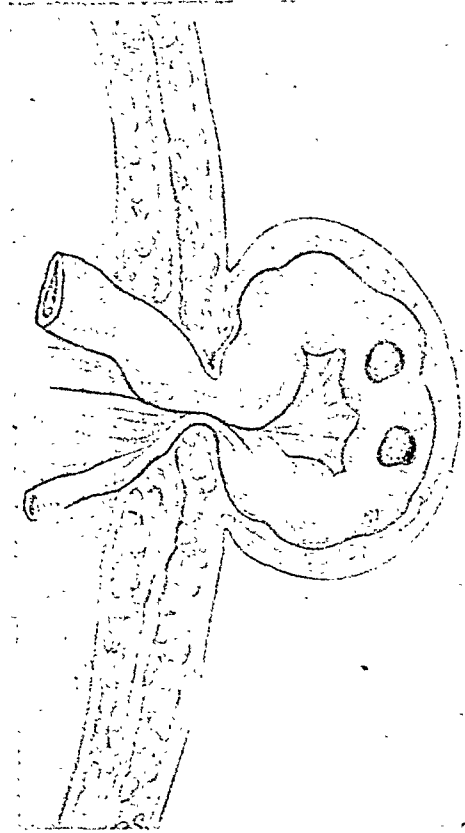


FIG. 2. Intramural hematomas of the transverse colon produced by manual pressure during an attempted reduction of a strangulated hernia. Ulcerative necrosis with the formation of a fecal fistula occurred ten days later. Recovery followed resection of the colon.

sellor and McCormack<sup>1</sup> have demonstrated that it is more prudent to combat the initial shock before attempting to repair the damaged bowel than it is to reverse this procedure. If the patient responds to the shock therapy within three hours, the prognosis is favorable for corrective measures can be employed before the peritonitis becomes disseminated. If the patient cannot summon sufficient reserve to rally from the shock, certainly he cannot withstand the added insults of an operation.

It is imperative that hemorrhagic shock be differentiated from the neurotraumatic variety.<sup>2</sup> In the former the loss of blood is the vital consideration and unless the hemorrhage is quickly controlled death

may ensue. Ruptures of the liver, spleen, pancreas and kidneys usually assume lethal proportions but spontaneous cessation does

employed with a nine year old boy. It is supplemented by inhalations of oxygen and the simultaneous administration of either blood

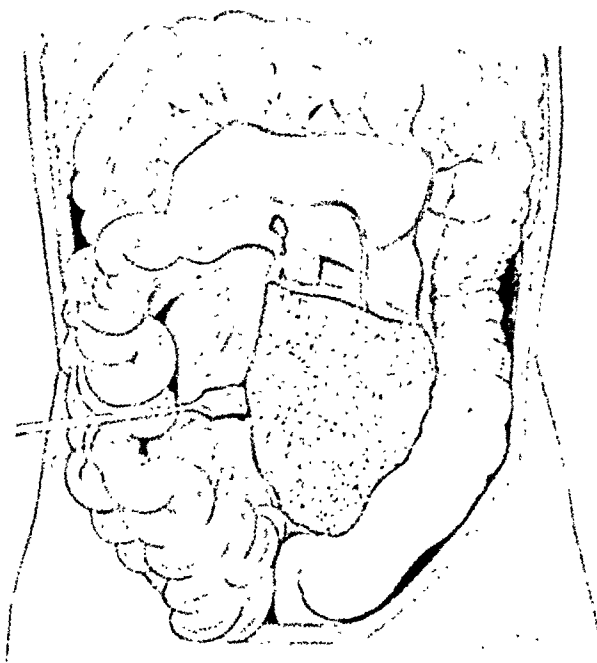


FIG. 3. Traumatic perforation on posterior jejunal wall which occurred three days after the primary injury. The resulting abscess occupied the entire left side of the abdomen and the pelvic gutter.

occur as in Case v (Fig. 5). A progressive tachycardia, decreasing blood pressure, air hunger, restlessness, and the presence of a doughy-mass in the rectovesical space is indicative of an internal hemorrhage. In severe lacerations of the parenchymatous organs one must attempt to arrest the bleeding at its source by direct sutures or packing. While any type of intervention is attended by considerable risk one has no other choice. Restoration of the blood volume by repeated transfusions of blood serum, blood plasma and whole blood have been very beneficial.

Spinal anesthesia supplies the complete muscular relaxation which is so essential for a rapid exploration. It can be administered very quickly and renders the entire abdomen insensitive, thereby permitting the desired type of corrective surgery to be employed. Its applicability is evidenced by the fact that it was successfully em-

or glucose solutions as dictated by the patient's general condition.

Reparative procedures should be done quickly and with a minimum of trauma. Whenever possible one should be content with closing the perforation or covering the defect with omental tissue. The laceration should be sutured in a transverse direction so as to enlarge rather than diminish the size of the bowel lumen. Time-consuming resections are to be shunned and if possible the simple expedient of exteriorization of the affected loops employed. This procedure decompresses the abdomen, removes the damaged segment and permits the patient to recuperate from the peritonitis before instituting reconstructive operations.

Duodenal and jejunal perforations present perplexing problems as the extravasating fluids produce a fulminating peritonitis due largely to their chemical components.

If the rupture is small and situated on the anti-mesenteric border, it can be closed by simple sutures. As a rule, however, the

hence, resection or plastic repair become inevitable. When smears of the peritoneal fluids indicate an active bacterial infec-



FIG. 4. Lacerations of the jejunum and its mesentery by a blow on the abdomen.

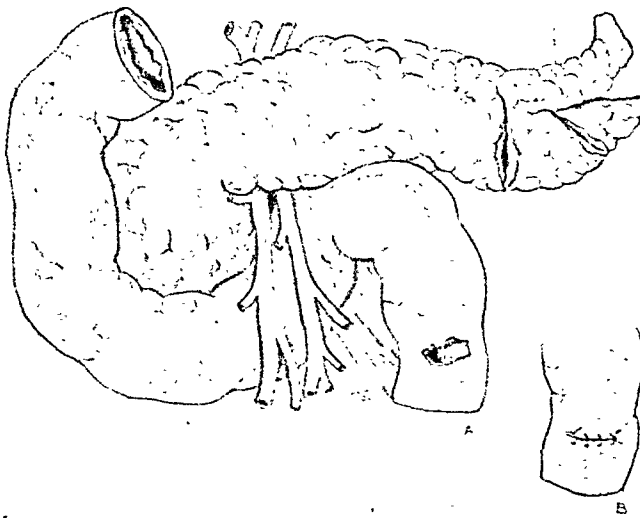


FIG. 5. A, perforation of anterior wall of the jejunum with multiple lacerations of the tail of the pancreas; B, closure of the perforation.

bowel has been crushed against the vertebrae producing so much necrosis that a mere closure is impossible. The injured loops cannot be exteriorized because of their ligamentous and peritoneal fixations,

tion, sulfanilamide should be employed immediately.

These patients require meticulous post-operative care.<sup>3</sup> The electrolytic and fluid balances must be maintained at the proper

physiologic level. Distention and vomiting can be minimized by the use of the Miller-Abbott tube. Continuous administration pattern of a clenched fist the hematomas were apparently produced by digital compression during the attempted reduction. The colon

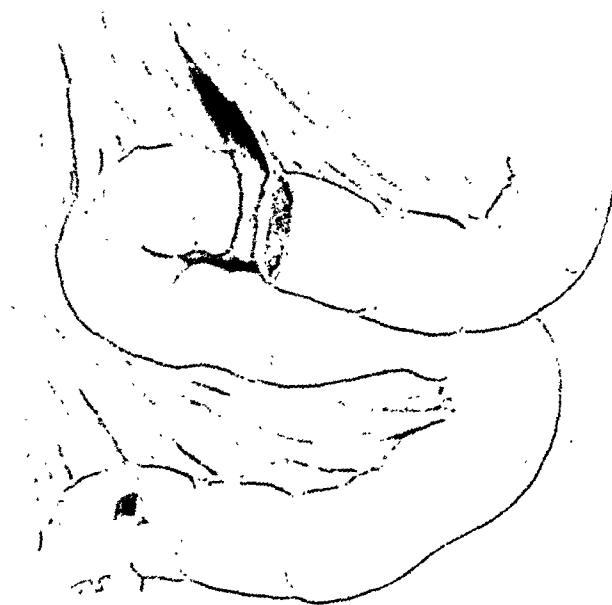


FIG. 6. Complete transverse laceration of the ileum and corresponding mesentery with an associated necrotizing ulcer caused by being struck in the abdomen by a swing.

of oxygen not only combats any tendency toward anoxemia but greatly reduces the incidence of cardiac and pulmonary infections. Vitamins, particularly vitamin C, should be given parenterally so as to stimulate the healing of the injured mucosal tissues and support the body in its fight against infections. Repeated transfusions with whole blood or its derivatives is an essential part of this program.

Successful therapy is predicated upon an early diagnosis, and prompt and energetic treatment. It is much easier to prevent such complications as peritonitis than it is to control them.

#### CASE REPORTS

**CASE I. Delayed Perforation of the Colon Resulting from an Attempted Reduction of an Umbilical Hernia:** A farmer, fifty-six years of age, had a strangulated hernia which, both he and his physician, had unsuccessfully attempted to reduce. An immediate laparotomy demonstrated an incarcerated loop of transverse colon which contained four small subserosal hematomas. As they conformed to the

seemed viable so it was returned within the abdomen and the hernia was easily repaired. On the tenth postoperative day there was a copious discharge of fecal material from the wound. The second operation revealed that two of the hematomas had slowly necrotized producing a delayed intestinal perforation. (Fig. 2.) The involved segment was resected and a complete recovery resulted.

**CASE II. Delayed Rupture of the Jejunum:** A nine year old boy fell from a high gate in such a manner that he struck his abdomen. After recovering his breath he complained of pain in the right elbow. There were no signs of fractures or internal injuries so he was sent home. Six days after the accident he complained of nausea, vomiting and intense abdominal cramps. An abdominal paracentesis confirmed the diagnosis of a generalized peritonitis from a ruptured viscus. On opening the abdomen intestinal contents could be seen escaping from a traumatic perforation of the jejunum. (Fig. 3.) The small lacerative opening was closed but in spite of adequate drainage, blood transfusions, chemotherapy and oxygen inhalations, he lived but sixteen hours.

**CASE III. Laceration of the Jejunum and Its Mesentery:** A boy, nineteen years of age.

was struck by an automobile. He remained unconscious for twelve hours and then aroused sufficiently to complain of intense abdominal

in the abdomen by a swing. She was knocked to the ground but immediately jumped up and resumed her play. Approximately twenty-



FIG. 7. A blow to the abdomen resulted in chronic intestinal obstruction due to ischemic fibrosis of the ileum and the corresponding mesentery. Note the dilated proximal loop.

pains. Thirty-six hours elapsed before he was admitted to the hospital where a diagnosis of a ruptured viscus was made. At operation, the terminal jejunum was found to be practically avulsed and its corresponding mesentery badly torn. (Fig. 4.) The severed bowel was re-united and the rent in the mesentery was sutured. In spite of active shock therapy the patient died three hours later from the effects of a fulminating peritonitis.

**CASE IV. Ruptured Ileum and Multiple Lacerations of the Pancreas:** A truck driver was thrown from his cab in such a manner that his abdomen struck a telephone pole and his head bumped the curb. He was rushed to the emergency hospital but relatives refused permission for an exploration until thirty-six hours had elapsed. The jejunum presented a punctate perforation on its anterior wall and the tail of the pancreas contained multiple stellate lacerations. (Fig. 5.) The lesser and greater omental cavities contained intestinal fluids, blood and pus. The jejunal perforation was easily closed by infolding sutures but no attempt was made to suture the pancreas as all bleeding had subsided spontaneously. He lived but eleven hours and autopsy revealed a generalized peritonitis.

**CASE V. Immediate and Delayed Ruptures of the Ileum:** A girl, six years of age, was struck

eight hours later she began to complain of abdominal cramps. A laparotomy disclosed a complete transverse laceration of the ileum with a generalized peritonitis. In the presence of the fulminating infection an end-to-end anastomosis was accomplished by means of the Murphy button. Ten days later she developed a fecal fistula and contrast roentgenograms indicated that the sinus tract communicated with the ileum several feet below the site of the Murphy button. Apparently the ileum had been injured in two places, the proximal one represented by the transverse avulsion and the distal one by a crushing injury which required ten days for complete necrosis to take place. (Fig. 6.) She died on the fifteenth postoperative day from peritonitis.

**CASE VI. Traumatic Avulsion of the Mesentery with a Benign Stricture of the Jejunum:** A laborer, seventy-five years of age, was struck in the abdomen by a falling plank. He was admitted to the hospital in a state of shock. He complained of nausea, vomiting, hematemesis and melena. Rapid response to therapy suggested a peritonism so he was treated conservatively. The recovery was most rapid. Ten years later he was readmitted because of an acute intestinal obstruction. An exploration revealed a complete fibrous occlusion of the terminal jejunum with a marked



dilatation of the duodenum and jejunum. (Fig. 7.) The regional mesentery was firm, scarred, and avascular. Apparently the old injury had damaged the mesenteric vessels producing the inevitable fibrous constriction of the bowel. The cicatrical segment was resected and his recovery was rapid.

#### SUMMARY

1. Traumatic perforation of the gastrointestinal tract by non-penetrating forces occur much more frequently than is appreciated. Five such cases are reported.
2. The immediate perforations occur at the time of the accident and are recognized by the accompanying peritonitis.
3. Delayed perforations occurred in 60 per cent of our cases and were not rec-

ognized until the inevitable peritonitis appeared.

4. Effective therapy consists in making an early diagnosis, administering energetic shock treatment, and applying corrective measures to repair the damaged bowel.

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It should be noted that the so-called umbilical hernia of adult life does not occur through the umbilicus. It is a protrusion through the linea alba just above the umbilicus or occasionally, just below that structure.

# HEPATOCHOLECYSTENTEROSTOMY FOR RELIEF OF JAUNDICE IN OBLITERATION OF THE HEPATIC DUCTS\*

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RE-ESTABLISHMENT of bile flow to the intestine after extrahepatic bile duct destruction, has provided the surgeon with an interesting and difficult problem. In general, and so long as there has remained any portion of the liver end of the bile ducts, the problem has resolved itself mainly into the use of two sets of procedures: (1) Those designed to reunite the bile ducts and restore a normal channel, and (2) those designed to unite the liver remnant directly to the intestine to form a "by-pass" of the distal remnant and the sphincter of Oddi. The choice of selection of one or the other means of restoration of bile flow is governed chiefly by past experience of the surgeon and the differences in existing conditions found in each individual patient. Seldom does the surgeon find a normal gallbladder and common hepatic bile duct present when the need arises for providing a means of restoration of bile flow to the intestinal canal. In our experience and in that reported by various authors, the gallbladder has usually been destroyed before or along with the destruction taking place in the other parts of the extrahepatic duct system. In a recent instance of this kind, not only was the gallbladder and common hepaticus preserved, but there could not be demonstrated any remaining portion of the liver remnant of the ducts.

Every case presents some inherent differences upon which the selection of the proper surgical procedure depends. The case reported herein was the first instance

in which we have attempted to unite the intrahepatic bile ducts to the gallbladder for re-establishing a normal flow and to the intestines for establishing a "by-pass" flow. We believe that the occasion will seldom arise when either of these procedures will have to be employed because of one factor common to most of our cases, viz., that the destruction of the bile ducts is most often associated with the surgical removal of the gallbladder, and that usually there occurs an external bile duct fistula during the course of the development of conditions necessitating an operation for the restoration of bile flow. The gradual suppression of bile excretion through an external bile duct fistula as the fistula opens and closes is accompanied by dilatation of the liver remnant. Dilatation of the liver remnant can be identified at operation as a bile blister in the region of the hepatic fissure. A process of this nature provides a dilated bile sac which can be anastomosed to some part of the intestinal tract. When the obstructive process occurs independent of external bile drainage and is of the type of fibrosing lesion found in our patient, there may never develop the usual bile sac at the hilum of the liver. Under this condition, either or both of the procedures reported herein offers a means of restoration of bile flow into the intestines.

Many questions remain unanswered, chief of which is will such a procedure provide for bile flow from the left lobe of the liver. In this instance we have no direct

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proof as to that. From the present lack of enlargement of the left lobe of the liver and the relatively low icteric index, we

ampulla of the gallbladder, which appeared on macroscopic inspection very much as the tissues in the region of the hepatic ducts

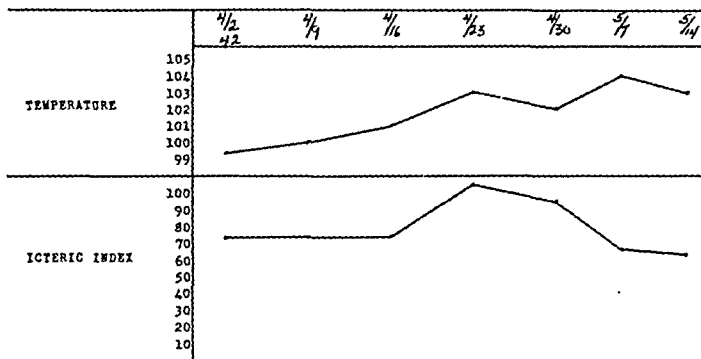


FIG. 1. A, temperature and icteric index curve during the period covering the first two operations.



FIG. 1. B and C, represents condition found at first and second operation.

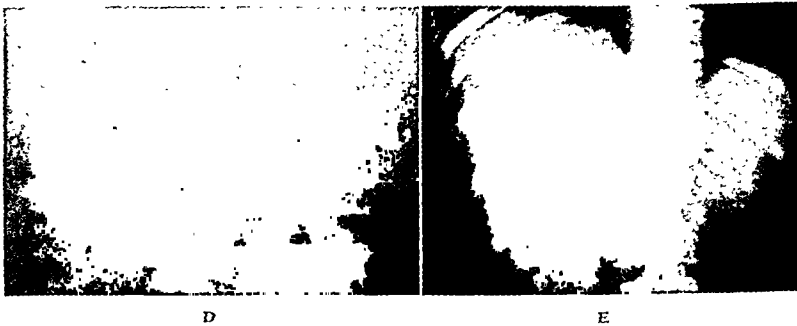


FIG. 1. D, cholecystocholangiogram showing collapsed gallbladder. E, x-ray showing high diaphragm on right side which was thought to be the result of a subphrenic abscess.

believe that this has been accomplished. The exact nature of the fibrosing lesion is also open to much controversial speculation. More comments upon this peculiar tendency for the extrahepatic bile ducts to undergo fibrosis are being heard in discussions of today. One recent case of linitis plastica type of carcinoma of the

in this patient, very strongly suggests that process as a possibility to account for the obstructing lesion in this patient. No satisfactory duct tissue offered itself for excision for biopsy study during the exploration of the region at operation (Fig. 1B) at the time when the condition was first considered to be permanent. Prior to this, at

operation (Figs. 1B and 1C), no thought of carcinoma was entertained. Infection was considered as the foremost cause and cultural specimens were considered to be adequate. A lymph node removed from the hepatic duct region at operation on July 21, 1942, three months after onset of jaundice, revealed only chronic inflammatory changes.

#### CASE REPORT

R. B., a female, age forty-eight was admitted to the New York Post-Graduate Hospital ward service on April 2, 1942. Her chief complaints were right upper abdominal pain of twelve days' duration; intermittent, aching sensation not influenced by taking of food or movements of the body; radiation to right shoulder and back region.

Associated symptoms were nausea but no vomiting. Jaundice was present which had its onset seven days previously and steadily increased. Clay colored stools and very dark urine had developed during those seven days, but there were no fever or chills. There had been a loss of seven pounds, attributed to nausea and lack of appetite. No previous attacks or symptoms of similar nature and no serious diseases or conditions of any relevant nature were reported.

Physical examination revealed the patient to be normal from a nutritional standpoint with deep, dark jaundice and suffering no apparent pain. The abdomen was normal in outline and contour. There was bilateral resistance in the upper half with moderate tenderness. Liver and spleen were not palpable and no gallbladder mass was felt.

The provisional diagnosis was acute cholecystitis with cholelithiasis and common duct obstruction by stone.

On admission the temperature and pulse were normal. Blood examination showed 3.8 red cells and 6.4 white cells; an icteric index of 75 units with a direct Van den Bergh of 4+ and indirect positive; bilirubin 15 mg. per cent; cholesterol total of 375 mg. per cent; esters 215 mg. per cent; blood amylase activity of 2.5 per cent; bleeding time of 2 minutes, coagulation time of 3 minutes. Wassermann test was negative; prothrombin clotting time 93 per cent of normal. Duodenal drainage on the second and third day after admission

revealed no bile flow into the duodenum. After antispasmodics on the fifth and sixth days there was still no duodenal bile specimen obtained. Fluoroscopic examination confirmed the presence of the tube, from which no bile returned, in the duodenum. The provisional diagnosis of common duct obstruction was confirmed. When the preoperative preparation was completed, the patient was ready for exploration on the sixth day after admission to the hospital.

The preoperative medical care and the subsequent medical care through the periods of obstruction without bile flow, obstruction and external bile flow, and the period of rehabilitation after natural bile flow had been established is worthy of report in detail, a period extending from April 2 to December 30, 1942, if space permitted. Suffice it to say that the surgical measures described as having been carried out in this case cannot possibly be undertaken and executed without the assistance of the most heroic medical measures obtainable today.

*First and Second Operation.* (Figs. 1A and B.) There is recorded in Figure 1A the average high temperature record during the period comprising the first two operations and up to May 20, 1942. During this period the average weekly high temperature ranged from normal during the week preceding operation to 103° and 104°F. Daily variations were typical of the true septic course seen in infectious cholangitis at the time of the second operation. (Fig. 1C.) Cultural examination of the gallbladder wall and gallbladder bile taken at the first operation gave negative results. Blood cultures taken at the time of the second operation were likewise negative.

The icteric index curve rose from 75 units on admission to 100 units midway between the first and second operation.

The operative findings at the first operation were surprising and confusing. The abdomen contained no fluid; the liver was two finger breadths below the costal margin, surface smooth and glistening and not adherent, color typical for early biliary cirrhosis. The gallbladder was normal in size and color, its walls moderately edematous. A more acute inflammatory process involved the cystic duct, hepatic duct and the tissues immediately in this region. Lymph nodes were enlarged and beefy, blood vessels engorged, and tissues generally edematous and swollen. The foramen

of Winslow was open through which the tissues comprising the gastrohepatic ligament were readily palpable. Lymph node enlargement at the cystic duct angle and from the hilus of the liver extended along the course of bile ducts to the superior border of the duodenum making up the principal of the mass in this region. The hepatic ducts above were not distinguishable separately from the lymph node mass. Below the cystic duct, the common bile duct was discernible and it appeared to be normal in size. No masses suggestive of stones were palpable on bi-manual manipulation through the foramen of Winslow.

The gallbladder was opened and found to contain a small amount of yellow tinged fluid; no stones were present. The interior surface appeared moderately congested and edematous. Probing of the cystic duct was not followed by bile flow into the gallbladder although the duct was demonstrated to be patent and not unduly dilated.

The entire process appeared to be one of acute inflammation involving chiefly the liver portion of the gastrohepatic omentum. The rest of the omentum showed no enlargement of nodes and none were found along the lesser curvature of the stomach. The pancreas and the nodes thereabout did not appear to be involved. No surgical means of draining the bile ducts above the zone of inflammation offered itself. No dissection of the acutely inflamed region above the cystic duct further than careful inspection for the usual bile duct sacculation previously seen in patients with common duct injury, seemed feasible. This could not be found in the mass of acutely inflamed glands and fibrous tissue.

A cholecystostomy tube was placed in the fundus of the gallbladder more or less upon the hope of a subsidence of the acutely inflamed zone and lymph node mass above the cystic duct. With the tube, free bile drainage to the exterior would be assured. Also cholecystocholangiographic studies would be provided for by a cholecystostomy for whatever light might be thrown upon what appeared to be a completely baffling problem to the operator at the moment.

A routine wedge-shaped biopsy of the anterior surface of the liver was taken. No unusual dilatation of the intrahepatic ducts or escape of bile from the wound was noted at this time.

Pathological examination of the liver biopsy and gallbladder wall revealed moderate biliary cirrhosis and mild cholecystitis. Cultural examinations were negative.

*Postoperative Course.* There was a normal reaction and no immediate temperature rise. Bile drainage from the cholecystostomy tube during the first twenty-four hours was 40 cc. in volume. On microscopic examination an occasional white blood cell, cholesterol crystal and 2+ amorphous substance was found. Chemical examination: Bile salt content, by Rheinhold-Wilson method, 200 mg. per cent; Aldrich-Bledsoe method, 700 mg. per cent; cholesterol, by Lieboff method, 40 mg per cent; pancreatic ferments—amylase, by Myers and Fine method, 15; lipase, by Cherry-Crandall method, negative; protease by Fermi Gelatin method modified by Myers, negative. Bile drainage continued for four days after operation; the volume ranged from 20 to 100 cc. with little change in concentration from that in the first day's output. One week post-operatively, bile drainage ceased altogether, as shown by chemical analysis of the small volume of colorless fluid drained through the cholecystostomy tube. Thereafter and until the second operation there was only an occasional specimen received from the tube in which low concentration of bile elements could be detected, an intermittent drainage of small amounts of bile in a continuous mucous drainage from the gallbladder up until the second operation one month later. The corresponding rise in icteric index from 50 to 104 units during this period indicated the drainage through the cholecystostomy tube and that possibly entering the duodenum to be far below normal.

Cholecystocholangiogram (Fig. 1D) taken by retrograde injection of hippuran following the first operation shows normal filling of the gallbladder and cystic duct with no opaque substance reaching the hepatic and common bile ducts.

The gradually rising and spiking temperature with the appearance of chills after three weeks suggested some complication or an extension of the inflammatory process. Negative operative cultures were confusing especially as the appearance at operation strongly suggested an infectious basis.

An x-ray (Fig. 1E) revealed an elevated right diaphragm which, taken with the clinical picture, indicated a possible subphrenic abscess.

Exploration of this region (Fig. 1c) was performed May 8th, one month after the first operation. No abscess of the subphrenic region or of the liver substance could be found. The region of inflammation beneath the hilus of the liver seemed to be completely frozen in a dense mass of fibrous tissue. The liver was further enlarged, more bile stained, and presented an appearance of severe biliary cirrhosis.

The cholecystostomy tube was changed and a second biopsy performed beneath the site of the previous incision.

Pathological examination of the liver tissue revealed pericholangitis and cholangitis. In addition to the previous lesion of obstruction and mild inflammation shown one month earlier, there was evidence of a severe inflammatory reaction around the intrahepatic ducts.

*Course Following Second Operation.* (Fig. 1A.) Following this operation, there was an appreciable improvement in the temperature and icteric index curves. Bile drainage from the gallbladder tube was negligible and very infrequent. The dressings about the tube began to show evidence of bile drainage, the first indication of drainage of bile from the biopsy wound. This source was not recognized at the time. It was attributed to poor function of the cholecystostomy tube. Irrigation and changing of the cholecystostomy tube was tried but the tube drainage of bile did not return as the dressings became more and more saturated with bile.

Cholecystocholangiography (Fig. 2D) by retrograde injection of hippuran through the cholecystostomy tube revealed a normal gallbladder, cystic duct, common bile duct, pancreatic duct and sphincter of Oddi action. These findings revealed the first indication of improvement in the inflammatory process about the ducts below the cystic union with the common hepatic in the region of the gastrohepatic ligament.

A more thorough exploration of the region around about the hepatic ducts seemed to be indicated by the x-ray. The third operation took place May 20th (Fig. 2B), twelve days after the exploration for subphrenic abscess. The region of the hepatic ducts was exposed and explored by "mousing" into this tissue with sharp, pointed forceps dissection. No structures resembling hepatic ducts could be identified after prolonged search. The tissue

in this region resembled sinew developed about any inflammatory process of long standing, viz., a grayish substance of such density that individual structures could not be distinguished as such. Dissection led to blind ends in a region in which exploration was fraught with the possibility of causing irreparable damage to the patient. After splitting the tissues in this region into shreds of nondescript masses, the search for the hepatic sacculation usually found in this region was abandoned.

The original biopsy wounds were exposed, the dome of the liver was found to be free of abscess as before, and a third biopsy performed in this region. No intent to establish external biliary drainage was entertained at this time. The intent of the biopsy was further observation in the course of the development of the stages of biliary cirrhosis.

*Course Following the Third Operation.* The severe septic clinical picture continued after the operation. Daily spiking temperature of 104° to 106°F. were preceded by chills and followed by exhaustion. (Fig. 2A.) The medical staff persisted in efforts to support the patient generally with a large carbohydrate intake. The vitamin, protein and carbohydrate intake were chiefly supplied by daily intravenous administration. Anemia was treated by frequent blood transfusions. Bile salt therapy by mouth and intravenous administration was resorted to. Following the latter, an increase in bile flow into the abdominal dressings was noted. However, the general condition of the patient seemed to be downhill as she continued to lose weight, run a septic course and show a gradually rising icteric index curve.

Drainage into the dressing and not through the cholecystostomy tube finally attracted sufficient attention to stimulate the attempt to inject the sinus around the tube to determine where the bile flow came from. The x-ray (Fig. 2E) shows a catheter inserted into the sinus above the cholecystostomy tube as it passed upward into the substance of the liver. This finally gave us a clue to work with, viz., to provide for an increase in the flow of bile from the intrahepatic ducts which had been inadvertently established through the biopsy wounds.

*Fourth Operation.* (Fig. 3B.) The cholecystostomy tube was removed and the external bile flow followed down to the point at which it was seen to be coming from the anterior

liver surface at the point of previous biopsies. Probing and dilating this small sinus as the liver substance was entered, a larger intra-

bladder and thence by the normal route into the duodenum. To accomplish this, the under-surface of the gallbladder was incised longi-

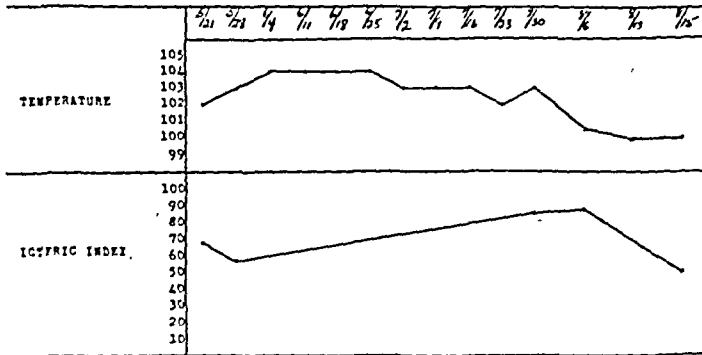


FIG. 2. A, temperature and icteric index curve throughout the course of the procedure from May 21st to August 15th.

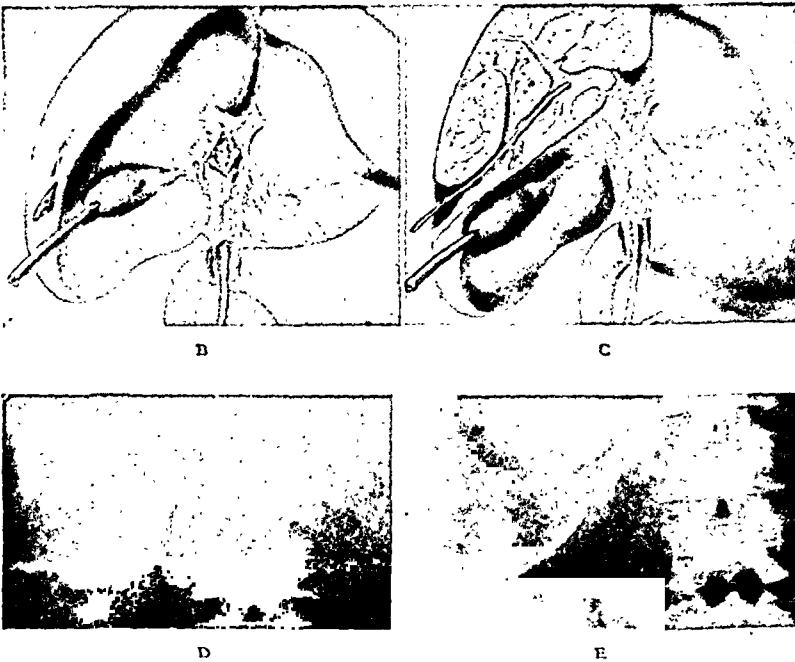


FIG. 2. B, exploration of the region of the common hepatic duct above the cystic duct.

FIG. 2. C and E, hippuran injected into the substance of the liver through catheter which passed through abdominal wall into the bile sinus.

FIG. 2. D, cholecystocholangiogram showing gallbladder, cystic duct, common bile duct and pancreatic duct filled with hippuran.

hepatic sinus was discovered. Into this sinus a No. 16 catheter could be passed for a distance of 12 cm. There flowed from this tube a full stream of amber colored bile containing flakes of fibrin.

Realizing that we had a serviceable gallbladder, cystic and common ducts present, we resolved to attempt to divert the flow of bile from the intrahepatic ducts into the gall-

bladder. Through the liver surface of the gallbladder there were made, with a cautery, fine deep puncture wounds. (Fig. 3B.) The sinuses were estimated to be made deep enough to transfix the dilated intrahepatic ducts. As these were made, there was profuse bleeding. To control this hemorrhage, we inserted wooden plugs, blunt ends of orange sticks, with a silk thread attached, by which the sticks could be

removed later through the cholecystostomy opening. The longitudinal incision into the inferior surface of the gallbladder was closed over the base of the sticks thus holding them

sacculation frequently found in the region of liver fissure in patients having had common duct obstruction. A lymph node was removed from this region for study.

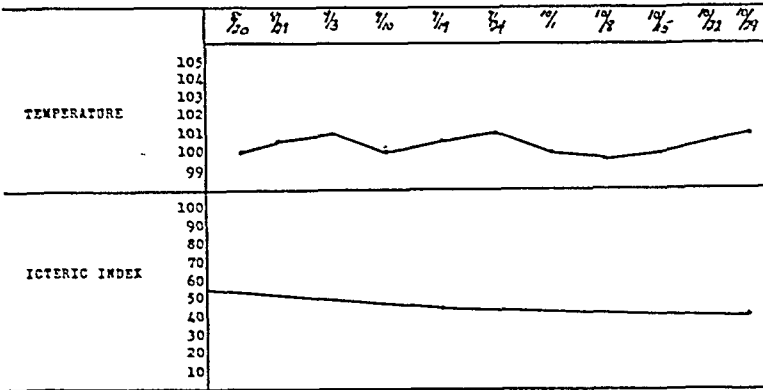


FIG. 3. A, temperature and icteric index curve following fourth operation.

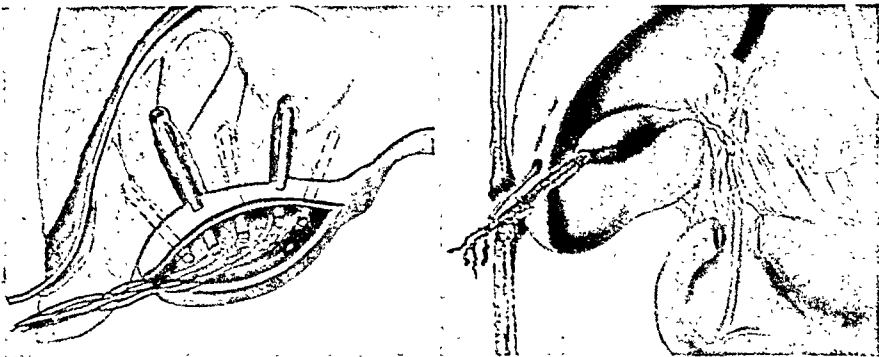


FIG. 3. B, drawing to illustrate the catheter passed into the liver through the bile sinus and means used to connect the intrahepatic bile duct to the gallbladder. C, gallbladder closed, silk threads from gallbladder and catheter in sinus brought out through wound.

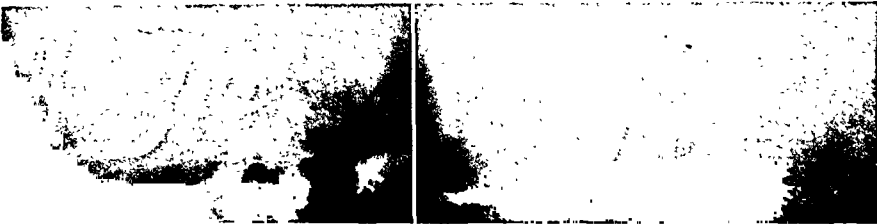


FIG. 3. D, injection of the liver sinus and gallbladder reveal dilatation of the intrahepatic duct and their communication from the right lobe of the liver to gallbladder and cystic, common duct and duodenum. E, shows close-up of cholecystocholangiogram done prior to the operation in Figure 3B.

firmly plugged into the liver punctures. The cholecystostomy tube was not replaced. The catheter in the intrahepatic ducts and the five silk threads were brought out with cigarette drains through the abdominal wound. (Fig. 3C.)

The hepatic duct region was again explored without finding evidence of bile blister or

Pathological examination of the lymph node revealed chronic inflammation. Cultures of the bile from the intrahepatic ducts showed, for the first time, gram-negative rods of the coli aerogenous group and Bacillus pyocaneus. Specimens of liver showed an acute and chronic inflammation of the liver with less evidence of biliary obstruction. Cultures of bile



from the intrahepatic duct drainage revealed *Bacillus coli*.

While the bile obstruction had been partially relieved by the external drainage from the biliary fistula, there remained a severe secondary infection of the liver.

The x-ray in Figure 3b shows large intrahepatic ducts in close proximity to the liver surface of the gallbladder into which we presumably carried the cautery incisions.

*Course Following the Fourth Operation.* (Fig. 3A.) As can be seen by the temperature curve, the septic condition began to respond soon after better drainage of the liver had been established. Liver damage was severe as is shown by the continued high icteric index curve. Chemical blood examination revealed an icterus index of 83 units, Van den Bergh direct 4+, indirect 8 mg. per cent; total cholesterol of 165 mg. per cent; esters of 60 mg. per cent, a ratio of 36 per cent; an indication of considerable liver damage remaining although an improvement over the low of 30 per cent esters at the time of the third operation. The white blood count dropped from 24,000 at the time of the third operation to 14,000 in one week's time. The chills disappeared, vomiting ceased and although the patient continued to run a temperature of 101° to 102°F., the spikes disappeared as the drainage from the intrahepatic duct tubes cleared up.

The silk threads with plugs attached were withdrawn from the gallbladder through the cholecystostomy opening sixteen days after operation. The intrahepatic duct catheter continued to drain more bile of better quality from day to day. Chemical analysis showed variation and a low bile salt and cholesterol concentration.

Shortly after the withdrawal of the wooden plugs, the dressing began to be saturated by bile flow. At the same time, the intrahepatic catheter drainage was discharging into a bottle by the side of the patient. Examination of the gallbladder sinus showed a slow trickle of amber colored bile to be coming from the cholecystostomy opening.

The general condition of the patient showed definite improvement in so far as sepsis was concerned. She was out of bed but very weak and emaciated. On August 15, 1942, she was discharged to the Gallbladder Out-Patient Clinic for observation and treatment, by the medical staff, for liver damage and replacement therapy resulting from external bile drainage.

*Course during Observation and Treatment in the Out-Patient Gallbladder Clinic.* There was a gradual decline in temperature and icteric index curves. Vomiting ceased and appetite improved. Some gain in strength and weight occurred. External flow of bile through the sinus from the intrahepatic ducts and that flowing from the sinus established between the gallbladder and intrahepatic ducts continued. So far as could be discerned, the majority of bile flow was external. The stools were light colored during this period. The urine discoloration cleared up. The icteric index curve came down to 40 units where it leveled off and became stationary.

The medical therapy during this period consisted mainly of a daily carbohydrate intake of from 400 to 500 Gm., 75 Gm. protein and little fat. Vitamins A, B complex, and D were given by mouth. Bile salts in 1 Gm. daily dose was administered. Iron and liver in capsule form was administered throughout this period.

There was never any indication of failing pancreatic digestion. Throughout the whole course, the blood pancreatic ferments were normal. No intestinal distention or steatorrhea occurred at any period.

*Final Operation to Convert External Bile Flow into Intestines.* By November 3, 1942, and approximately seven months after the onset of disease, the patient was adjudged to have reached the point in general recovery and rehabilitation in presence of external bile drainage at which surgical restoration of internal bile flow could safely be attempted. At this time the daily temperature curve did not exceed 100°F. The icteric index curve was fixed at about 40 units. General strength and stamina were below normal but very much improved over that at discharge on August 15th.

*Second Admission—November 3, 1942.* The temperature course on admission and during a week's observation did not exceed 100°F. (Fig. 4A.) The blood chemical examination revealed an improvement in liver function—icteric index 34 units; cholesterol total 168 mg. per cent; esters 85 mg. per cent, a ratio of 51 per cent; bromsulphalein test 12 per cent at thirty minutes and 8 per cent at sixty minutes. Blood count revealed red cells of 3.23, hemoglobin 51 per cent and 15,500 white blood cells. Abdominal examination showed no signs of acute infectious process. The liver and spleen are not palpable.

Bile flow from the abdominal sinus was continuous and not attended by digestion and excoriation of the abdominal wall. A wooden

duct system of the right lobe of the liver. They were separated by a portion of normal skin 1 cm. in width.

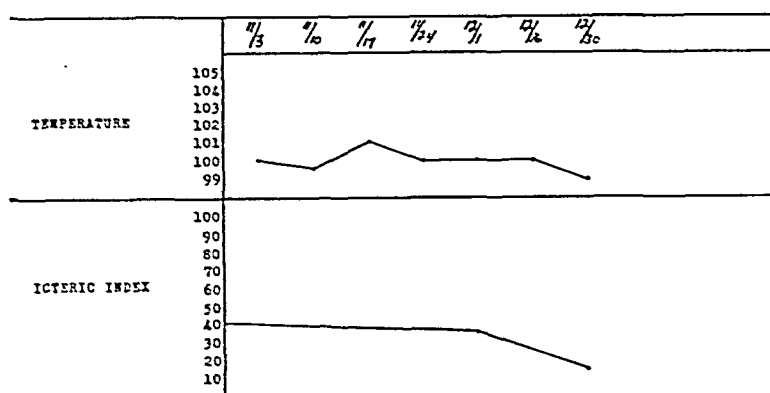


FIG. 4. A, clinical course following final operation.

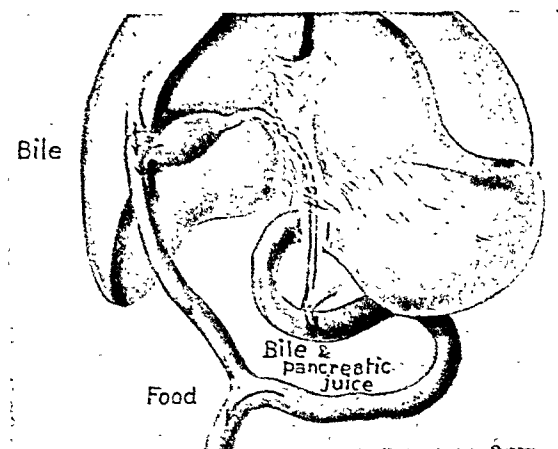


FIG. 4. B, the arrangement of the intrahepatic bile duct and fundus of the gallbladder union to the intestine after the final procedure.

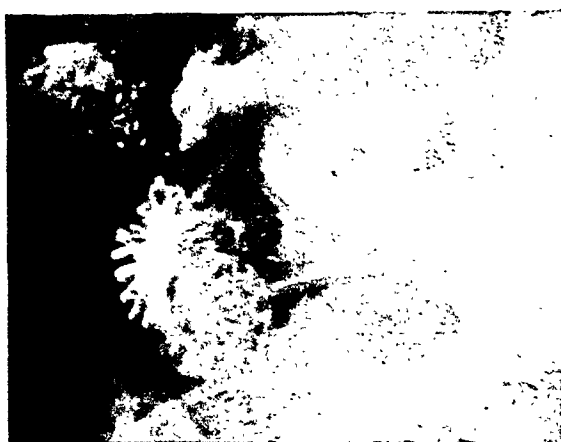


FIG. 4. C, visualization with barium meal of jejunal intestinal loop leading up to the bile sinus of the intrahepatic duct and gallbladder.

plug was strapped with adhesive across the opening in the skin with an immediate obstructive reaction of discomfort, nausea and vomiting accompanied by a slight temperature rise. Following this experience, the surgical staff gave up all hope of the external biliary fistula closing spontaneously. Operative closure was deemed to be necessary.

The patient was prepared by blood transfusion and forced intravenous therapy to undergo operation.

**Final Operation.** (Fig. 4A and Fig. 4B.) On November 12, 1942, about seven and one-half months after the onset of illness and during a period in which there had been little or no normal bile flow into the intestinal tract, operation for restoration of this flow was undertaken. The abdominal incision presented two small openings in the outer angle of a paracostal type of incision. One of these sinuses led into the gallbladder and the other into the intrahepatic

An approach to the problem of anastomosing these two openings to the intestinal tract was begun by making an incision circumscribing both openings and leaving a margin of skin 1 cm. in breadth on all sides. The remainder of the paracostal incision was opened along the pre-existing scar line. The circumscribing incision was carried down and through all the layers of the abdominal wall. The paracostal incision likewise was opened up completely exposing the right upper quadrant of the abdomen. The button of tissue containing the two sinus openings and made up of the abdominal wall was left adherent to the anterior surface of the right lobe of the liver and fundus of the gallbladder. The two sinuses through the button of tissue lead into the gallbladder and intrahepatic ducts, respectively.

No attempt was made to explore the seat of the former inflammatory zone in the hepatic duct region. The stomach appeared to be

normal. Around the hepatic flexure of the colon the upper jejunum was identified and brought up into the abdominal wound. The gut was clamped and cut transversely. Incision into the mesentery was carried back to its base far enough to allow for carrying the distal cut end of the gut up to the button of tissue containing the two external bile fistula openings.

An anastomosis between the open distal jejunal end and the skin button was carried out by approximating catgut sutures including the skin margin of the button and the open end of the distal segment of jejunum. Reinforcing sutures of interrupted silk were placed around the union of the skin button and jejunal anastomosis. (Fig. 4B.)

The proximal end of the severed jejunum was anastomosed to a longitudinal incision into the side of the jejunum at a convenient level. The opening in the jejunal mesentery then was closed. (Fig. 4B.)

*Postoperative Course to Date.* Within an hour following the last operation, the patient vomited bile stained fluid. The first definite indication of bile flow into the intestine in almost eight months. The postoperative course was normal. There was no leakage of jejunal fluid from the wound. The wound healed by primary intention. The patient was discharged back to the Gallbladder Clinic on the fourteenth postoperative day.

The stools began to show evidence of bile content soon after the last operation. The patient's appetite and general strength improved. Gradually the administration of bile salt and vitamins were withdrawn as the general dietary intake increased. Iron and liver extract have been continued during the period since last operation.

To date and four months following last operation, the patient's general health is fair. There has been a gain in weight of fourteen pounds. The stools are normal in color. The icteric index is 15 units. Abdominal examination shows no spleen or liver enlargement. Duodenal drainage attempted one month

after operation did not result in recovery of bile from the duodenum as the tube was shown by fluoroscopy not to enter the duodenum. While we do not have any direct evidence of the establishment of a normal flow of bile from the gallbladder to the duodenum on the basis of the operation to connect the intrahepatic duct mucous membrane to the gallbladder mucous membrane by growth along the sinuses made by cautery, we believe that such a system probably exists from the appearance of bile drainage from the cholecystostomy wound, vomiting of bile postoperatively and the preoperative x-rays showing this tract to be open below the gallbladder.

X-rays (Fig. 4C) taken two and a half months following the last operation, following barium meal by mouth, show the intestinal loop leading up to the bile sinus and fundus of the gallbladder to be functioning. No barium is seen to enter the gallbladder or intrahepatic ducts.

#### COMMENT

It is on the belief that we have established mucous membrane union to mucous membrane, intrahepatic duct to gallbladder, that we hope for permanent relief in this patient. The sinus leading from the intrahepatic ducts and from the fundus of the gallbladder will, we believe, close in time due to the contracture of the fibrous tissue in its wall. The latter assumption is based upon results in our experience with the formation of a false tract "Sullivan Procedure" to anastomose the two ends of the intrahepatic ducts. We have come to believe that all procedures in this field should have as their prime object for permanent success, the union of intestine to bile duct and an approximation of all the layers of both without the intervention of any foreign substance whatsoever.



# EVALUATION OF SULFONAMIDES IN THE TREATMENT OF PERITONITIS OF APPENDICEAL ORIGIN\*

## A REVIEW OF 903 CASES OF ACUTE PERFORATIVE APPENDICITIS

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OF the approximate 30,000 deaths which occur each year in the United States from peritonitis, nearly two-thirds are a result of acute appendicitis with perforation. This high mortality offers a constant challenge to every surgeon to find a treatment of peritonitis which will reduce these figures. During the decade prior to 1940, in various sections of the country, some progress was made in lowering the mortality. The apparent factors responsible for this improvement were adequate restoration of fluid and chemical balance, decompression of the gastrointestinal tract, a more direct approach to the appendix, and the proper indications for surgical intervention.

In 1940, Stafford and Sprong reported a mortality of 10 per cent in a series of 479 cases of perforated appendicitis with either abscess or peritonitis treated by immediate surgery. In a series of cases reported by Barrow and Ochsner in which appendiceal peritonitis was treated both by immediate surgery and conservative measures, the mortality was 27.3 per cent.

With the advent of sulfanilamide, an additional weapon for combatting peritonitis was recognized. The use of this drug in the treatment of appendiceal peritonitis was begun in 1936, and in 1940 Ravdin, Rhoads, and Lockwood demonstrated that sulfanilamide could be recovered from the peritoneal cavity as well as from the blood when given subcutaneously. The first report of the intraperitoneal use of sulfanilamide for peritonitis of appendiceal origin was made in 1940 by Dees of Mem-

phis, Tennessee. This favorable report was quickly followed by considerable experimental as well as clinical evidence of the value of sulfonamides used intraperitoneally for controlling the peritoneal invasion of organisms particularly in the preperitonitis stage.

Thompson, Brabson, and Walker reported fifty-nine cases of severe acute appendicitis without a fatality in which intra-abdominal sulfonamides were used. A very recent report of Walter and Cole showed the therapeutic value of intraperitoneal sulfadiazine both for the treatment and prevention of peritonitis.

### ANALYSIS OF CASES

However, in the numerous clinical reports available there are no large series of appendiceal peritonitis cases showing mortality rates over a period of several years and compared with the mortality of years previous to the use of sulfonamide therapy. In order to obtain these comparative mortality figures, a careful survey was made at the Los Angeles County General Hospital of 903 consecutive cases of acute appendicitis with perforation or abscess formation. This study included a four-year period from 1939 to 1942 beginning with the year in which sulfonamides were first used parenterally and the following three years in which sulfonamides were used with increasing frequency both parenterally and intraperitoneally.

**Mortality.** During the three years previous to 1939 the mortality rate for perforated appendicitis had shown some

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decrease and was attributed as previously mentioned to better surgical judgment, a more careful attention to chemical and as frequently in males as females. These figures both for age and sex incidence parallel quite closely other series of cases

### *Chemotherapy - Perforative Appendicitis*

#### *903 Cases - L.A.G.H.*

<i>Year</i>	<i>Intraperitoneal Sulfonamides</i>	<i>Intraperitoneal and Parenteral</i>	<i>Mortality Percentage</i>
1939	0	12 %	9.2
1940	13 %	58 %	7.1
1941	78 %	85 %	5.7
1942	98 %	98 %	3.4

FIG. 1.

fluid balance, the routine use of gastrointestinal decompression, and the use of the McBurney incision. As shown in Figure 1 the mortality has gradually decreased from 9.2 per cent in 1939 to 3.4 per cent in 1942. It would seem that from as large a series of cases as presented here, that definite clinical observations could be made in evaluating the effectiveness of sulfonamide chemotherapy in peritonitis.

*Age and Sex.* An interesting observation, made in this group, was that the incidence of perforated appendicitis reached its peak between the ages of eleven to twenty, almost one-third of the cases occurring in the second decade of life. The mortality rate reached the lowest point in the third decade of life almost coinciding with the age group containing the greatest incidence of disease. The ages of these patients ranged from the youngest of eighteen months to the oldest patient of eighty-seven years; and as shown in Figure 2, the mortality increased toward both extremes of life although it was twice as high during the latter decades, as compared with the first ten years of life.

The disease occurred more than twice

for acute appendicitis in general which have been reported throughout the country.

*Duration of Symptoms.* The duration of symptoms of appendicitis before perforation occurred was measured in terms of onset of complaint to the time of operation when a perforation was discovered. This group of 789 excludes cases of perforation with abscess which were drained without appendectomy, as they gave a long and many times indefinite history previous to surgery. Over 8 per cent of these patients gave evidence of a perforation within twelve hours of the onset of symptoms. The highest incidence of perforation occurred between thirty-six to forty-eight hours with more than two-thirds of all the cases occurring within forty-eight hours of the onset of symptoms. There were very few cases with perforation after seventy-two hours. (Fig. 3.)

*Type of Operation.* All of the 903 patients in this series were operated upon and the diagnosis of perforative appendicitis verified at the time of surgery. Patients with appendicitis not operated upon were omitted from this series in order to eliminate any inaccuracy of diagnosis; also these cases gave no opportunity to observe

the effect of sulfonamides applied in the peritoneal cavity. Non-operative therapy was used only in terminal cases of general

about one-fifth of all the perforations were associated with some degree of abscess formation. The abscess cases receiving

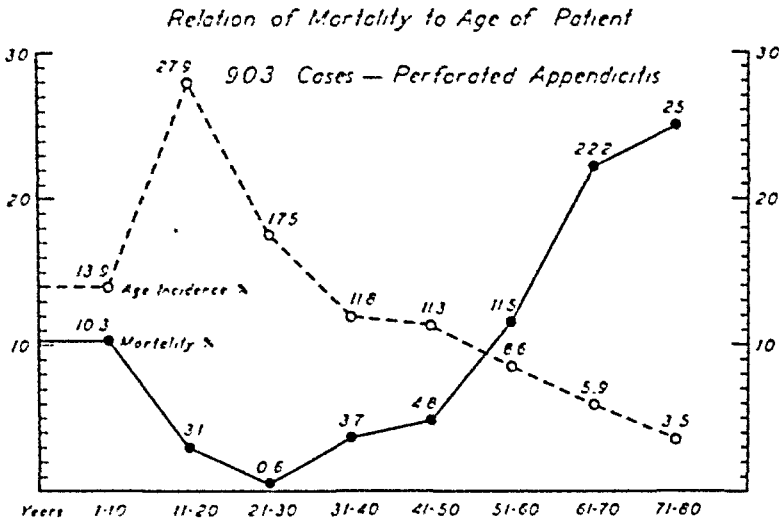


FIG. 2.

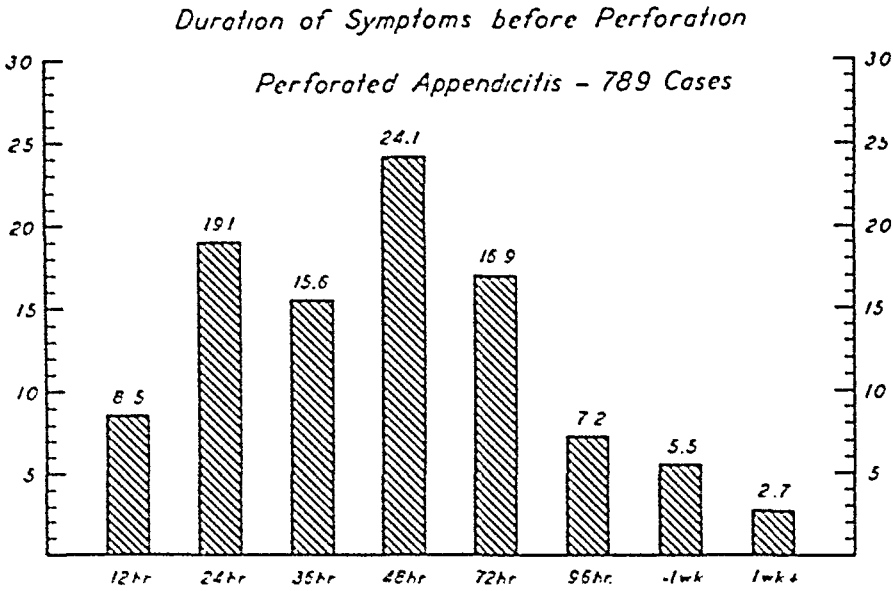


FIG. 3.

peritonitis, or in cases in which a very definite localized mass was palpated in the abdomen. Appendectomy was performed in 789 cases and in the remainder simple incision and drainage of an abscess was done. In 1939, the mortality of the cases drained was 26 per cent as compared with no deaths in this group during 1942. The decrease in mortality in the appendectomy group was not as marked but showed a steady decrease during the four years as illustrated in Figure 4.

One hundred seventy-four cases, or

operative intervention were those in which no definite mass was palpable preoperatively or the group of cases in which an abscess continued to increase in size in spite of conservative treatment. During 1939, appendectomy was done in approximately one-fourth of the abscess cases and the remainder were drained with a resulting mortality of 21 per cent for all the abscess cases during the year. A comparison is made (Fig. 5) with the year 1942 during which over three-fourths of the abscess cases had appendectomy with no

deaths. The procedure of incision and drainage without appendectomy was used only in those cases with a completely walled

portant trend is noted in the decreasing tendency of the surgeon to drain the peritoneal cavity in the presence of peritonitis.

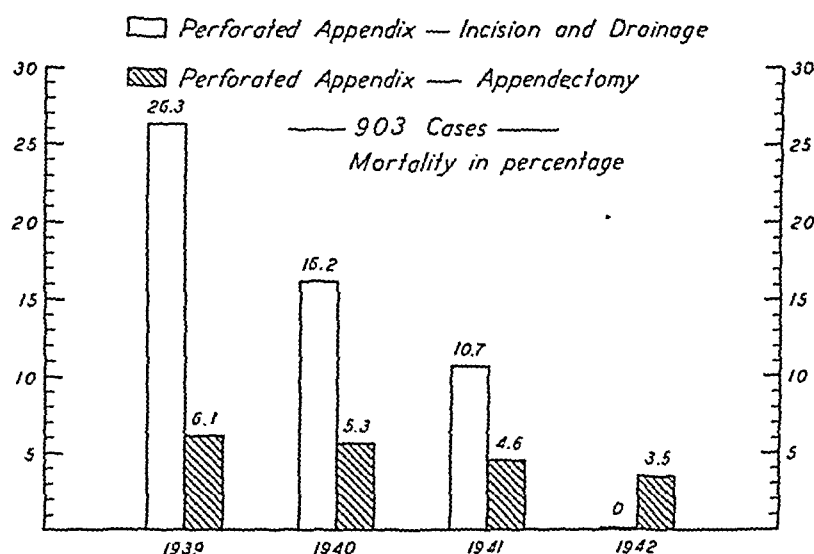


FIG. 4.

# Perforated Appendicitis with Abscess

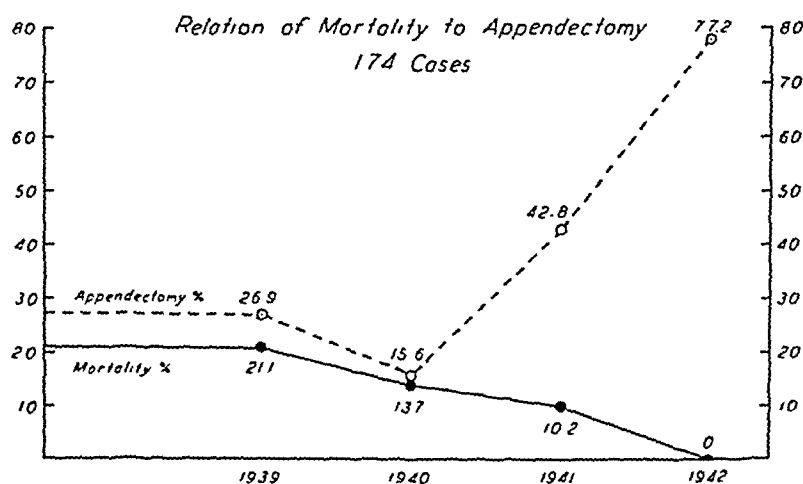


FIG. 5.

off abscess entirely free from the general peritoneal cavity and approached whenever possible through an extraperitoneal route. During the entire four-year period, about one-third of the abscess cases had appendectomy. These figures show an increasing tendency toward the removal of the appendix whenever possible. The decreasing mortality attendant with this procedure would warrant its use.

*Drainage of Peritoneal Cavity.* An im-

It has long been a known fact, as shown by Yates in 1905, that the drainage of the general peritoneal cavity is physically and physiologically impossible. Many of the surgeons have continued, however, to use drainage for local or spreading peritonitis and to follow the dictum, "when in doubt, drain." The advent of sulfonamides used intraperitoneally has given the surgeon courage to leave out the drain with greater frequency. In 1939, over 90 per cent of

the cases were drained with one or more penrose drains, whereas in 1942 (Fig. 6) about one-third of the patients had no

sprinkle one ounce of sulfanilamide powder into the peritoneal cavity at the site of perforation and over the surrounding

*Perforated Appendicitis - 789 Cases*

*(Abscess cases not included)*

*Percentage of Cases not Drained*

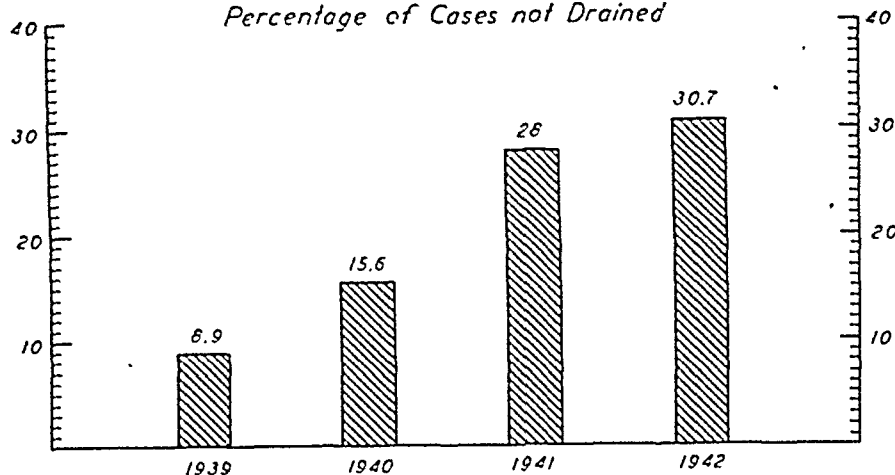


FIG. 6.

drains at all and in many more the drain in the wound extended only to the peritoneum in order to handle any secondary infection in the subcutaneous tissue, which is less resistant to infective organisms than the defense mechanism of the peritoneum.

**Sulfonamide Chemotherapy.** Sulfanilamide in 0.8 per cent solution was used subcutaneously in a few of the cases during 1939, but none locally in the peritoneal cavity. The following year over half of the cases received sulfonamide therapy of some type, either sulfanilamide solution subcutaneously or 5 per cent sulfapyridine intravenously and a few cases had intraperitoneal sulfanilamide. During 1942, only three cases did not receive any form of sulfonamide chemotherapy and one case received only parenteral therapy. The remainder all received intraperitoneal sulfonamides and two-thirds of these also were treated with parenteral sulfonamide, these being almost entirely 5 per cent sulfathiazole by vein. The intravenous therapy was usually given in 2 Gm. doses every eight hours beginning twenty-four hours after surgery and continuing until a total dose of about 20 Gm. was given. The technic of using sulfonamide intraperitoneally when first applied was to

structures. Subsequently, the crystalline form was found to be better absorbed than the powder and with less foreign body reaction. The dosage of drug used varied from 5 to 15 Gm., but an average of 8 to 10 Gm. was the usual amount implanted in the peritoneal cavity, and 1 to 2 Gm. frequently sprinkled in the abdominal wound. Absorption of the drug by the peritoneum has been shown to be very rapid by Jackson and Collier, who carried out their studies both on patients and on dogs. A 10 Gm. dose of sulfanilamide given intraperitoneally will usually produce a peak blood level of approximately 10 mg. per 100 cc. within two to three hours, which falls off gradually to low levels at the end of twenty-four hours. The local peritoneal concentration of the drug may be a hundred times or more the level reached in the circulating blood.

**Sulfanilamide versus Sulfathiazole.** Following the experimental study of Throckmorton in 1941 on the peritoneal response to sulfathiazole, this sulfonamide was used frequently in place of sulfanilamide. Epps, Ley and Howard, and Pearl and Rickles have also shown that the local application of sulfathiazole has certain advantages over the other sulfonamide compounds:



(1) It is active against a variety of organisms; (2) it is innocuous to the peritoneum while at the same time stimulating the

looked, but no evidence of permanent hepatic injury was found in this series.

*Analysis of Causes of Mortality.* The

### *Analysis of Death - Perforated Appendicitis*

903 Cases - 61 Deaths - 36 Autopsies

	1939	1940	1941	1942	Total
<i>Diffuse Peritonitis</i> .....	11	6	5	4	26
<i>Diffuse Peritonitis and Pneumonitis</i> ...	7	8	3		18
<i>Pneumonitis</i> .....	2	1	1		4
<i>Pulmonary Embolism</i> .....	1	1	1		3
<i>Coronary Thrombosis</i> .....		1	2		3
<i>Pulmonary Tuberculosis (advanced)</i> ....		1	1		2
<i>Congestive Heart Failure</i> .....	1				1
<i>P.O. Hemorrhage (Jaundice)</i> .....		1			1
<i>P.O. Shock</i> .....				1	1
<i>Lung Abscess</i> .....	1				1
<i>Cerebral Embolism</i> .....			1		1

FIG. 7.

local cytologic defense mechanism; and (3) it exerts a prolonged bacteriostatic effect. During the year 1942, sulfathiazole was used intraperitoneally in one-third of the cases, the microcrystals being preferable to the powdered drug in that it caused less caking. Sodium sulfathiazole was not used intraperitoneally as recommended by Fox because of the excessive alkalinity of the sodium salt solution resulting in tissue irritation.

*Toxic Effects.* No deaths in this series of cases could be attributed to the toxic effects of sulfonamide therapy. Hematuria occurred in three cases, twice in patients using sulfapyridine parenterally and once with the use of sulfathiazole. The intraperitoneal use of either sulfanilamide or sulfathiazole apparently produced no more toxic effects than would be expected by the oral or parenteral use of the drugs. Three cases of jaundice were noted following the use of sulfanilamide, but all cleared rapidly after discontinuing the parenteral use of the drug. The importance of possible liver damage in these cases must not be over-

most common causes of death from perforated appendicitis are peritonitis and pneumonitis. The term pneumonitis as used here includes postoperative atelectasis, bronchopneumonia, and lobar pneumonia. As shown in Figure 7 both peritonitis and pneumonitis in the same patient were frequent causes of death. Autopsies were performed in over one-half of the deaths so that the causes of death were diagnosed with accuracy. The results of sulfonamide treatment are indicated in a decrease in peritonitis, and a marked decrease in pneumonitis following the use of sulfapyridine and sulfathiazole. The one case with jaundice at the time of death had received no sulfonamides during the hospital stay. The five deaths during 1942 were all poor risk cases, two of them being over sixty years of age and other three had been delayed after perforation for a number of hours before surgery.

*Morbidity.* The postoperative morbidity is almost as important an indication of the success of surgical therapy as the mortality. In these cases, the most common

complications of perforative appendicitis, of abscesses of the upper abdomen beneath namely, pneumonitis and abscess, are the diaphragm was practically unaffected. summarized in Figure 8. The use of sul- An interesting observation made was that

### *Morbidity - Perforative Appendicitis*

*903 Cases - L.A.G.H.*

<i>Year</i>	<i>Pneumonitis</i>	<i>Pelvic Abscess</i>	<i>Subphrenic</i>
1939	16	35	3
1940	17	22	1
1941	6	21	3
1942	2	9	2

FIG. 8.

### *Mortality - Perforated Appendicitis*

*903 Cases - L.A.G.H.*

<i>Year</i>	<i>Cases</i>	<i>Deaths</i>	<i>Mortality %</i>
1939	250	23	9.2
1940	266	19	7.1
1941	242	14	5.7
1942	145	5	3.4

FIG. 9.

fanilamide, either intraperitoneally or parenterally, had practically no effect on the incidence of postoperative pneumonitis, but the use of the more recent sulfonamides has shown a marked effect in decreasing this complication.

The abscesses following the peritonitis of perforation, localize most frequently in the pelvis although subphrenic abscesses are by no means uncommon. The incidence of postoperative pelvic abscess was apparently decreased by the use of intraperitoneal sulfonamides, whereas the occurrence

only about one-half of all the abscesses required surgical drainage, the others either drained spontaneously or subsided by resolution and absorption.

#### COMMENT

This analysis of cases has been presented with the full realization of the difficulty in evaluating any therapy on the basis of statistical information. Inasmuch, as the experimental background for this therapy has been so thoroughly covered in recent literature, it was believed that a further

presentation of clinical material to cover a large number of cases on a general hospital rather than any small group of selected cases would be of definite value.

A further criticism is also realized in view of the yearly decrease in mortality of acute appendicitis at the Los Angeles General Hospital in the past, it might be expected that the present decrease in mortality would continue without the use of sulfonamide therapy. Also a question that arises is, would not the same results be achieved by the use of parenteral sulfonamides alone without the use of intraperitoneal implantation?

The comparison of mortality decrease with the use of sulfonamides (Fig. 9) appears to be more than coincidental and would seem to indicate a direct relationship between the increased use of sulfonamide therapy particularly the intraperitoneal use of the drug and the consistent decrease in mortality during the past four years.

#### SUMMARY

A study was made of 903 cases of perforative appendicitis at the Los Angeles General Hospital, in order to evaluate the use of sulfonamides in the treatment of peritonitis.

During the five-year period 1939 to 1940, the mortality rate for perforated appendicitis decreased from 9.2 to 3.4 per cent.

Sulfonamides were used with increasing frequency so that 98 per cent of all the cases during 1942 received some form of chemotherapy. The mortality rate decreased each year as the use of sulfonamides increased.

Morbidity as well as mortality was reduced as observed by the yearly decrease in the frequency of postoperative peritoneal abscesses and pneumonitis.

Drainage of the peritoneal cavity following appendectomy was used less often, as sulfonamides were used intraperitoneally in nearly all cases. In 1942, one patient out of three had no drain used, either in the peritoneal cavity or abdominal wound.

In abscess formation following appendiceal perforation the procedure of choice

was incision and drainage only in the completely walled off abscess. In 1942, appendectomy was performed in over three-fourths of the abscess cases without fatality.

Clinical observations on a large group of cases apparently confirm the experimental evidence that sulfonamides are an effective form of therapy in the treatment of peritonitis. Their use is of particular value when implanted intraperitoneally during the early stages of peritonitis in perforative appendicitis.

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# KIDNEY SURGERY\*

REVIEW OF CASES AT THE SOUTHERN PACIFIC GENERAL HOSPITAL  
FROM 1930 TO 1943

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THIS paper consists of a statistical review of kidney operations performed in the Southern Pacific General Hospital from 1930 to 1943. Through the co-operation of the Departments of Roentgenology and Pathology as well as that of the medical, surgical and house staffs, pathological diseases residing in the remote and deep-seated organs such as the kidney have been brought to light. During the past thirteen years, it has been our object to detect surgical conditions of the kidney early before advanced infection or total destruction has set in. When it is possible to investigate these cases in their preliminary stages, the surgical intervention which would eventually become inevitable may sometimes be averted, and the likelihood of obtaining relief by conservative measures is enhanced.

It has been justly stated that the diagnosis of diseases of the kidney is the most precise in medical practice. Equipped with this tremendous advantage, urologic surgeons are still confronted with the problem of how best to benefit the patient with established kidney disease. Keen evaluation of the individual case coupled with sound surgical judgment based on wide experience and technical ability is our only present basis for determining the most expedient procedure for the individual case. Nephrectomy is a comparatively simple and sure method of obtaining clinical cure, and is the only choice in some cases. In others, however, nephrectomy needlessly sacrifices an organ containing an effective amount of functioning tissue. Conservative renal surgery is both offensive and

defensive in action. Its timely application serves to prevent destruction of the kidney as well as to preserve healthy renal tissue. In cases in which it is deemed justifiable to allow the sound portion of the kidney to remain, the patient is left furnished with a reserve which will enable him to combat more vigorously any subsequent urological emergency. Moreover, should reparative surgery prove inadequate, or should one or the other kidney later become the seat of disease requiring nephrectomy, the radical operation can still be performed.

Our goal has been restoration insofar as possible of normal renal physiology, the merits of which have not always been sufficiently appreciated. There is no gain-saying that to do so often taxes the resourcefulness as well as the discernment and skill of even the most experienced conservative surgeon. Although it is believed by some that compensatory hypertrophy of the acquired single kidney establishes the necessary renal counterbalance, hypertrophy of the contralateral kidney has been proved not to occur in partial nephrectomy, the remaining portion of the resected organ (which does not atrophy) carrying on adequately in its intended physiological manner. A long list of patients relieved of suffering and disability is an impressive testimonial to the efficacy of conservative interventions on the kidney. In this report we have reviewed the lesions for which radical and conservative surgery were performed. We have made this analysis with the aim of bettering our surgical judgment, improving our technic and reducing our already low mortality which compares

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favorably with that of leading urological services of the country.

Between January 1, 1930, and July 1, 1943, 643 surgical interventions on the kidney were performed at The Southern Pacific General Hospital. Of these, 112 were radical and 531 conservative. (Table I.)

TABLE I

## CLASSIFICATION OF OPERATIONS ON THE KIDNEY

<b>Nephrectomy</b>	
Renal tumor.....	17
Tuberculosis.....	15
Hydronephrosis (with stone, 6).....	22
Pyonephrosis (with stone, 4; with cyst, 1).....	22
Pyohydronephrosis (with stone, 2).....	6
Pyelonephritis (sclerosing, 4; with stone, 5).....	9
Nephrolithiasis.....	5
Adrenal tumor.....	1
Ruptured kidney and ureter.....	2
Aneurysm of renal artery.....	2
	<hr/>
	101
<b>Nephroureterectomy</b>	
Hydronephrosis with ureteritis cystica..	2
Carcinoma of kidney pelvis and ureter..	2
Primary carcinoma of ureter with hydronephrosis.....	2
Hydronephrosis with ureteral calculus..	4
Pyohydronephrosis with hydroureter...	1
	<hr/>
	11
<b>Conservative Kidney Operations</b>	
Nephropexy.....	92
Nephrolysis.....	92
Ureterolysis.....	92
Renal sympathectomy.....	94
Nephrolithotomy.....	34
Pyelolithotomy.....	33
Drainage of perinephritic abscess.....	18
Drainage of kidney abscess.....	6
Plastic operations on ureteropelvic junction.....	14
Renal resection (for biopsy, 1).....	11
Removal of aberrant renal vessel.....	13
Nephrostomy drainage (calculus pyonephrosis, etc.).....	21
Excision of kidney cyst.....	3
Decapsulation of kidney.....	3
Curettage of kidney sinus.....	2
Débridement of kidney sinus.....	2
Detorsion of kidney pedicle.....	1
	<hr/>
	531
Total.....	<hr/>
	643

**Mortality.** The mortality for all kidney operations reported in this series was 2.2 per cent. In 112 nephrectomies there were

eight deaths, or a mortality of 7.1 per cent. The causes of death were: metastasizing kidney cancer (two); coronary occlusion (two); pneumonia (one); circulatory collapse (one); shock (one); paralytic ileus (one). Three of the eighteen patients nephrectomized for cancer died, a mortality of 16 per cent. It is generally acceded that removal of a kidney for cancer carries the highest mortality in renal surgery. We attach substantial significance in our favorable statistics to the exclusive use of the lumbar retroperitoneal approach. The type of nephrectomy performed has a definite influence on mortality, and we attribute a large measure of our success to careful selection of technic and to pre-operative and postoperative care. There were seven deaths after classical nephrectomy. One death in six cases of nephrectomy par morcellement occurred in a sixty-seven-year old man presenting pyohydronephrosis and ectopia. There were no deaths following the subcapsular method employed by us in four cases; none after two-stage nephrectomy in twelve critically ill patients and none after clamped nephrectomy in twelve.

The mortality following conservative kidney operations is naturally lower than that following radical intervention. It was relatively low in our series, six deaths occurring in 531 patients, or 1.1 per cent. Causes of death were: pulmonary edema and intestinal obstruction (one); septicemia (three); pneumonia (one); coronary occlusion (one). The number of deaths after nephrolithotomy was the highest. The accepted rate is about 15 per cent and was 8 per cent in our hands. Possibly, inadequate drainage was responsible for the development of septicemia after nephrolithotomy in one case, because no nephrostomy or pyelostomy tube was employed. More recently, the thorough lavage of kidney wounds with physiological salt solution followed by the sprinkling of about 4 Gm. of sulfanilamide powder in the wound has reduced wound infection and lessened the incidence of septicemia.

One death followed pyelolithotomy, giving a mortality of 3.3 per cent in thirty-three cases; the usual mortality rate in pyelolithotomy is conceded to be about 7 per cent. It is interesting to note that no deaths followed eleven consecutive partial resections of the kidney for localized calculous pyonephrosis, polar cyst, hydrocalycosis with and without stone formation, etc. One kidney later had to be sacrificed by nephrectomy on account of multiple cortical abscess formation. Combined nephrolysis, ureterolysis, nephropexy and renal sympathectomy proved to be a benign operation; the mortality was nil in ninety-two consecutive cases. In one case in which adrenal tumor was suspected, exploratory lumbotomy failed to reveal this lesion; ptosis was encountered, and nephropexy and sympathectomy were carried out. The patient died three days later from coronary occlusion. This death can hardly be chalked up against nephropexy as the operation was not deliberately performed. It is gratifying to report that there were no deaths from postoperative anuria, the former bugbear of kidney surgery. This complication, that was so frequent in the early days of kidney surgery, has been eliminated by forced fluid intake and the intravenous administration of glucose solution prior to operation.

#### NEPHRECTOMY

*Classical Nephrectomy.* This was employed in the majority of our cases requiring radical surgery (78 out of 112 cases). The lumbar retroperitoneal route was routinely used and proved consistently satisfactory. The transperitoneal attack was not employed on account of its higher mortality and more serious complications. In twelve patients presenting large tumor or destructive lesions existing in the high placed, adherent kidney, it was necessary to remove the twelfth rib, and in one the eleventh as well, in order to obtain adequate exposure. After clamping the kidney pedicle, the vessels were ligated individually or *en masse*. Early clamping of the

renal pedicle and gentle handling of the tissues in nephrectomies for malignancy minimized metastasis by preventing the dissemination of cancer cells into the bloodstream during manipulation of the kidney.

*Nephroureterectomy.* Complete nephroureterectomy was performed in eleven cases presenting carcinoma of the kidney pelvis, primary carcinoma of the ureter, ureteritis cystica, renal tuberculosis and hydronephrosis associated with megalo-ureter or calculous ureteritis. The lower portion of the ureter was exposed by a separate retroperitoneal incision in the lower abdomen, and in cases of neoplasm of the renal pelvis and of primary growths of the ureter the intramural portion was thoroughly fulgurated.

*Subcapsular Nephrectomy.* The technical difficulties encountered in extirpating the kidney presenting extensive adhesions were diminished by the application of subcapsular nephrectomy. It is the only safe method that can be employed in patients presenting pathological conditions complicated by extensive adhesions, as it preserves the integrity of the pleura and peritoneum. The successful outcome obtained in the four cases in which this operation was deliberately chosen bears out this point.

*Nephrectomy par Morcellement.* In certain pathological conditions the kidney was so friable that it could not be extirpated intact. In six cases of this type we removed it in pieces.

*Two-stage Nephrectomy.* This was performed on twelve critically ill patients for the relief of partially or totally closed hydronephrosis complicated by infection, stone or rupture, pyonephrosis associated with tuberculosis or calculus and perinephritic abscess accompanying cortical abscess formation or destructive renal lesion. These patients were in no condition to undergo the operative shock attending immediate radical removal of the diseased kidney, and probably would not even have survived the anesthetic. Under local anesthesia, therefore, the first stage consisting

of nephrostomy drainage was done, and after ten to fourteen days when sufficient improvement warranted, nephrectomy was carried out. By employing early nephrostomy, we were able to save several kidneys which were otherwise destined to be sacrificed by nephrectomy. We believe that the choice of this procedure was an important factor in reducing our mortality for nephrectomy, and that it enabled us to offer a life-saving alternative to patients who would have been abandoned as hopeless.

*Clampless Nephrectomy.* This is the latest modification and was utilized in twelve of our series. Clampless nephrectomy is applicable to pathological conditions occurring in anomalous kidneys with peculiar distribution of the blood vessels, as well as to certain anatomically normal kidneys in which it is possible to ligate the vessels separately or *en masse*. It has been successfully carried out in cases of tuberculosis, hydronephrosis, pyonephrosis and ectopic kidney with destructive disease. We are satisfied that in our cases it was followed by less shock, fewer complications and smoother convalescence than the clamp method. Such observations have led us to apply this more benign form of nephrectomy to a greater number of cases.

#### CONSERVATIVE OPERATIONS

*Repair of Hydronephrosis.* One of the most destructive pain-producing and debilitating of renal phenomena which is capable of correction is hydronephrosis. In a few of our cases it was congenital in origin, but in the great majority it was of the acquired type. It was caused by obstructive lesions consisting of ureteral stone, valve or stricture formation of the ureteropelvic junction, extrinsic lesions exerting pressure on the pelvic outlet, or kinked ureter due to renal ptosis. In this review we are not discussing the great number of patients who were treated by cystoscopic maneuvers consisting of ureteral dilatation, removal of stone, etc. Surgical relief of hydronephrosis in our fourteen patients included

correction of the obstructing lesion and repair of the dilated pelvis. In those cases associated with pain, renal sympathectomy was simultaneously carried out; in those presenting renal ptosis nephropexy was performed. We adhered to the principle of nephrostomy or pyelostomy drainage, and employed the ureteral splint in order to avoid postoperative distortion of the ureter. Application of these essential technical points prevented progressive destruction of the kidney.

*Nephrolithotomy and Pyelolithotomy.* In dealing with kidney stone, several factors were considered before deciding on the form of operation best suited to the individual case. The condition of the contralateral organ, associated renal disease and the position, size and shape of the calculus were carefully evaluated. In some patients nephrectomy was mandatory. If conservatism was warranted, we used pyelolithotomy whenever possible (thirty-three cases), as it is accompanied by less hemorrhage, sacrifices no renal tissue and is followed by fewer complications than nephrolithotomy. However, by employing nephrolithotomy (thirty-four cases), one is less liable to leave stones behind when there are incrustations in the papilla of the kidney. A combined pyelotomy and nephrotomy incision advocated by the author proved the most satisfactory for removal of certain staghorn and tricornute calculi. Routine drainage of the calculus kidney by nephrostomy or pyelostomy was carried out in order to reduce intrarenal tension caused by postoperative edema. At the time of operation, pathological conditions favoring stone formation were corrected as far as possible: the ptosed kidney was suspended, the painful kidney denervated, obstructive lesions of the ureteropelvic junction relieved and the poorly draining, infected hydrocalyx resected.

*Renal Resection.* Resection of a portion of the kidney is indicated for benign pathological lesions localized to either pole in the anatomically normal kidney as well as in the congenitally anomalous organ. Its

special merit lies in the treatment of localized lesions of the solitary kidney and the various types of diseased anomalous kidney with separate blood supply. Heminephrectomy was performed for removal of the distended half of a double pelvis and the hydronephrotic half of a horseshoe kidney. In patients presenting polar lesions such as solitary cyst, infarct, abscess, carbuncle, localized pyonephrosis, etc., the kidney can be saved, as these lesions are amenable to resection. In our group of cases, renal resection was applied to localized pyonephrosis in one and solitary polar cyst in three. Primary ligation of the nutrient blood vessels eliminated the unpleasant complication of primary and secondary hemorrhage. We were able to remove successfully and with minimal loss of kidney substance the above localized renal lesions by employing the wedge-shaped excision extending into healthy tissue. The cut surfaces were approximated with chromic mattress sutures mounted on lubricated atraumatic needles, and the flaps replaced and ligated over pieces of fat. In four cases of calculi located in the lower calyx associated with ulcerative pyelonephritis, resection of the lower pole was carried out. This procedure prevented recurrence of stone by removing the poorly draining, chronically infected lower calyx. Renal resection for biopsy was performed in one instance. All but one of these patients made good recovery and are now leading normal lives. This one later required nephrectomy because of subsequent abscess formation. Repeated follow-up examinations revealed no recurrences. One cannot fail to recognize that these individuals were benefited by a conservative kidney operation which, rather than depriving them of an entire vital organ only a part of which was diseased, preserved the healthy functioning portion to maintain its physiological rôle. The greatest care in selection of candidates is absolutely essential, as is precision technic; but the recompense of restoring health and length-

ening life is being reaped by an ever increasing number of progressive kidney surgeons.

*Nephrostomy.* Under certain conditions nephrostomy is a life-saving procedure. When ureteral catheterization failed to relieve calculous anuria resulting from complete obstruction of the solitary kidney, we resorted to nephrostomy or pyelostomy drainage as the only hope in three cases. Nephrostomy was utilized six times prior to two-stage nephrectomy for obstruction and in six patients presenting pyonephrosis. In one outstanding case in this group, the first stage (nephrostomy) proved sufficient and converted the proposed treatment from a radical to a conservative intervention. Among the eleven others was the case of W.H., who entered the hospital in an extremely weakened, toxic condition and in severe shock. Examination revealed spontaneous rupture of the kidney with extravasation of urine, infection and hydronephrotic enlargement with stone formation. His condition was so poor that the first operation,—consisting of drainage of the kidney and perirenal tissues,—was carried out under local anesthesia. Following this intervention the temperature rapidly dropped to normal, and the patient soon regained his strength. Two weeks later, subcapsular nephrectomy was performed and the operation was crowned with success. Nephrostomy was also used by us prior to diversion of the urine by ureterocutaneous or uretero-intestinal anastomosis, and in rare instances for diagnosis.

*Drainage of Perinephritic Abscess.* In dealing with our eighteen cases of perinephritic abscess, we employed copious drainage, using cigaret drains or the petrolatum gauze type, and removing a little of the packing each day—usually taking from ten to fourteen days for its entire removal—so that the abscess cavity would heal from the bottom. We advise against the common practice of removing the entire drain in twenty-four to forty-eight hours, because the superficial portion of the wound



may heal, allowing the original abscess to reform often in larger proportions than before.

In cases of perinephritic abscess secondary to destructive inflammatory conditions of the kidney in which nephrectomy is indicated, we recommend a two-stage operation as described under that heading. A case exemplifying the value of drainage preliminary to nephrectomy for secondary perinephritic abscess is that of S. M., aged fifty-nine, who was admitted to the hospital in a seriously debilitated condition. Examination revealed a calculous, tuberculous pyonephrosis and secondary abscess involving the perirenal tissues of the loin, as well as a huge abscess that had perforated the diaphragm and extended into the pleural cavity as far as the second rib. The first stage operation consisted of drainage of the lower perinephritic abscess. In ten days the patient's condition was so improved that nephrectomy was safely carried out, at which time it was necessary to remove the twelfth rib. Two weeks later a third operation was performed, consisting of drainage of an enormous abscess involving the chest cavity. In order to obtain adequate drainage, the eleventh rib was resected and the extensive abscess cavity thoroughly lavaged with physiological salt solution and packed with five yards of petrolatum gauze. The gauze was slowly removed, and after many weeks' convalescence the wound healed and the patient was discharged restored to good health.

*Nephropexy.* It is gratifying to remark that nephropexy now occupies its proper place among the conservative operations on the kidney. Ptosed kidneys are prone to chronic infection and stone formation by reason of stasis, and dependent drainage should be re-established at the earliest possible moment. The operation is clearly indicated in that group of patients suffering from pain, gastrointestinal symptoms and nervous phenomena caused by ptosis and torsion of the kidney. It is routinely employed by us for surgical suspension of

the ptosed kidney which has been exposed for another conservative operation. In the present series, the author's method of nephropexy was used in most cases, preceded by nephrolysis and ureterolysis. Kinked ureters were released from adhesive bands or aberrant vessels; the kidney pedicle was carefully exposed, providing a clear field for the delicate operation of denervation. The most minute technical details were observed in order to assure lasting fixation of the kidney in its normal anatomical position. In cases presenting torsion of the kidney, detorsion was carried out. In one, the kidney pedicle was twisted to such an extent that it interfered with renal circulation, jeopardizing the integrity of the kidney. Detorsion and nephropexy in this case replaced the kidney in its normal position and relieved the patient of severe attacks of Dietl's crisis. The excellent results obtained in the ninety-two patients on whom nephropexy was performed have been a source of great satisfaction to us, and have increased our already staunch support of this beneficent kidney operation.

*Renal Sympathectomy.* Papin, in 1920, first observed experimentally that severance of the sympathetic nerve fibers of the kidney had no appreciable untoward effect on the functioning power or drainage of this organ. In 1921, he performed renal sympathectomy on the human being for relief of painful hydronephrosis of small size. This operation was soon adopted by the enterprising kidney surgeons of the world, and is now in general use for painful obstructive conditions of the kidney such as hydronephrosis, ptosis and torsion, nephralgia, sympatheticotonia, painful hyperdynamic mobility of the renal pelvis, etc. It was originally performed by the author in 1925, and in 1932 by him for the first time at The Southern Pacific General Hospital on a young woman with nephralgia. Although the operation is highly technical and requires scrupulous atraumatic handling of the renal vessels, it is a benign procedure as evidenced by the fact that there were no deaths in the ninety-

four patients on whom it was employed in this series.

*Renal Decapsulation.* This operation was first attempted with the object of increasing the collateral circulation of the kidney. It was practiced in cases of acute nephritis associated with uremia and anuria and for the relief of chronic Bright's disease in patients in whom other methods failed. Thorough trial proved the transitory nature of its decompressive action on the kidney, and it has now been virtually abandoned by us (three cases in 531 conservative operations).

#### CONCLUSIONS

The low mortality rate and excellent results obtained by nephrectomy in this series illustrate what can be accomplished by proper selection of cases, meticulous technic, careful preoperative and postoperative treatment and the judicious choice of the type of nephrectomy in a given case. The gratifying results obtained by the various conservative kidney operations analyzed in this review present an impressive testimonial to the preservation of renal tissue and the relief of suffering.

#### SUMMARY

1. A review of 643 kidney operations performed at The Southern Pacific General Hospital between January 1, 1930, and

July 1, 1943, was made with the object of bettering surgical judgment, improving technic and reducing mortality.

2. One hundred twelve nephrectomies and 531 conservative operations are reported.

3. The mortality for all operations on the kidney was 2.2 per cent: nephrectomy 7.1 per cent; conservative interventions 1.1 per cent.

4. The mortality for nephrectomy was unquestionably lowered by the exclusive use of the lumbar retroperitoneal route and by careful selection of the type of nephrectomy best suited to the individual case, viz., the two-stage operation; clampless nephrectomy; subcapsular extirpation; removal par morcellement.

5. Our efforts to preserve renal tissue are exemplified by the fact that we performed six times the number of conservative operations as radical. Gratifying results were obtained by the following conservative procedures: surgical correction of hydro-nephrosis; nephrolithotomy or pyelolithotomy for removal of stone; resection of a portion of the kidney for localized polar lesions; renal sympathectomy for relief of pain; nephropexy for the correction of painful renal ptosis, and the life-saving measure of nephrostomy prior to two-stage nephrectomy and ureterostomy and for drainage of the obstructed solitary kidney.



# THE OUTLOOK ON CARCINOMA OF THE STOMACH

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CARCINOMA of the stomach constitutes one of the most serious of all medical problems. A favorable outcome in a patient with cancer of the stomach is more common now than in the past, primarily because of improved diagnostic methods and better surgical technic. Many patients die each year without entering a hospital for treatment. Oughterson<sup>1</sup> reported that in New Haven, Connecticut, only 58.0 per cent of these patients were treated in a hospital and Saltzstein and Sandweiss<sup>2</sup> found a 59.0 per cent hospitalization of 365 consecutive deaths from carcinoma of the stomach in Detroit.

There are many impressive reports on the treatment of carcinoma of the stomach, especially from large clinic practices. A truer picture of the cancer problem is to be found in the statistics of unselected cases such as are seen in every community in the United States.

In order to evaluate the trends and end results in a large group of unselected cases, the admissions for cancer of the stomach in two large general hospitals were reviewed. This study included 970 patients with gastric malignancy admitted to Harper and Receiving Hospitals for the fifteen year period from 1928 to 1942. Harper Hospital is a 600 bed general hospital devoted almost entirely to the care of private patients. Detroit Receiving Hospital is a 500 bed city hospital devoted to the care of charity and indigent patients. This made possible an immediate division and comparison of the cases from two distinct social and economic groups.

## HARPER HOSPITAL

During this fifteen-year period, 1928 to 1942, there were 454 patients treated for

carcinoma of the stomach in Harper Hospital. This is an average annual admission of thirty patients. The ratio of males to females was 2 to 1 or 302 males to 152 females. The average age for the entire group was fifty-eight years and the age extremes were from thirty to ninety-three years. Of this entire series, 192 patients or 42.3 per cent were considered to be clinically inoperable and entirely without hope of cure. The hospital mortality rate for this group of inoperable patients was 26.5 per cent. It is evident from these figures that one-fourth of the patients who enter the hospital are in such a critical condition that they die of the disease in a relatively short time.

Fifty-seven per cent of all patients admitted to Harper Hospital were submitted to surgery. This ratio conforms very well with the reports of operability given in the literature. There was an operative mortality rate of 43.1 per cent for the 262 patients submitted to surgery. The operative procedures performed were exploratory laparotomy, jejunostomy, gastrostomy, excision of the ulcer, gastroenterostomy and subtotal gastric resection. The disposal of the 454 patients with carcinoma of the stomach is clearly illustrated in Figure 1.

Of those patients submitted to surgery, 111 or 24.4 per cent of the entire series were found to be inoperable and biopsy or nothing at all was done. The mortality rate for this group of patients was 26.1 per cent. During this fifteen-year period only four jejunostomies, three excisions of ulcers and seven gastrostomies were performed, amounting to 3.1 per cent of the entire series.

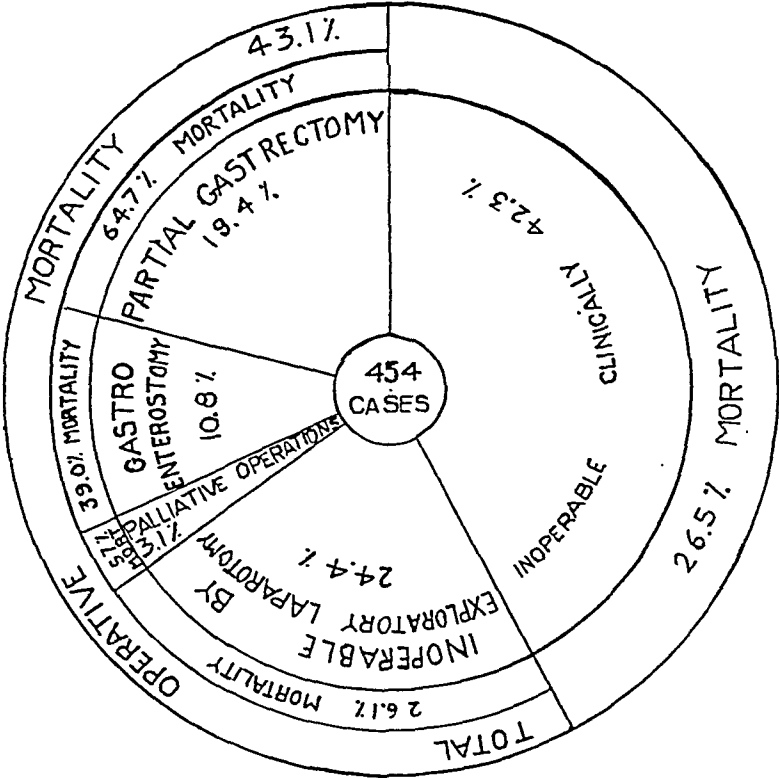


FIG. 1. Distribution of carcinoma of stomach, Harper Hospital, 1928-1942.

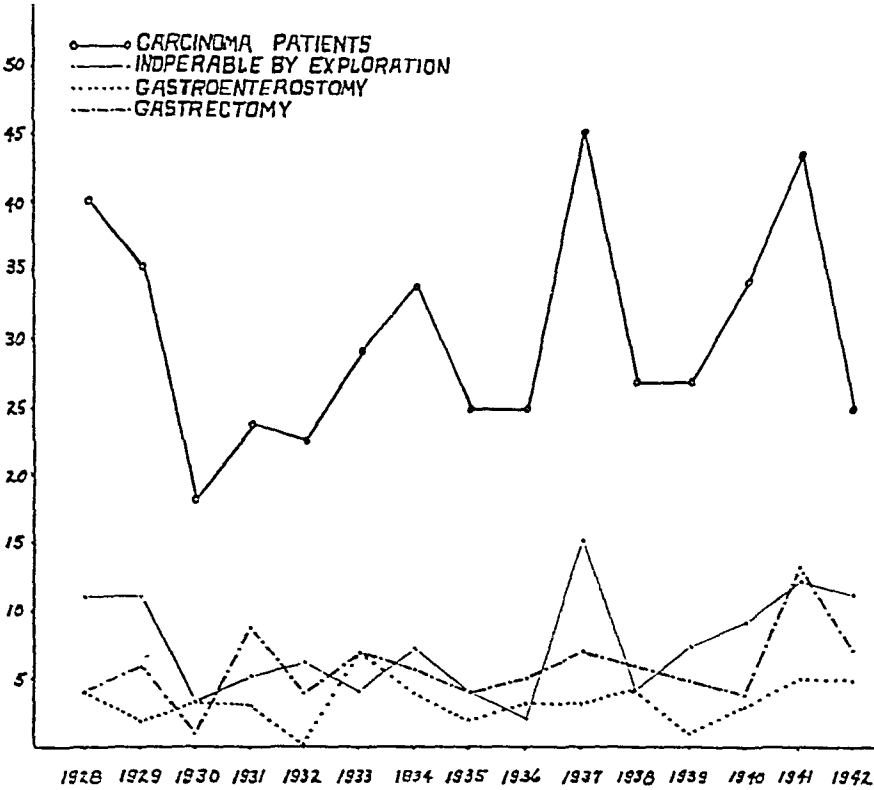


FIG. 2. Trends in treatment at Harper Hospital.

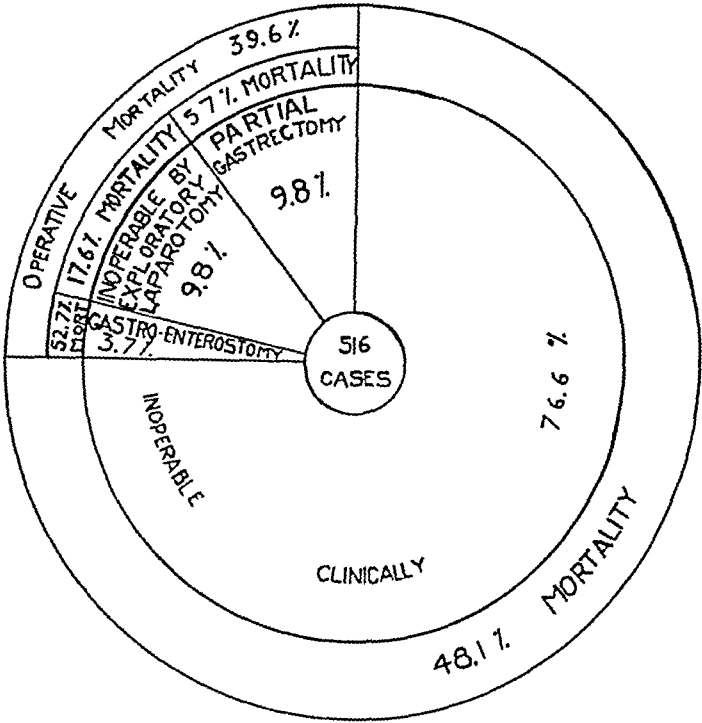


FIG. 3. Distribution of carcinoma of stomach, Receiving Hospital, 1928-1942.

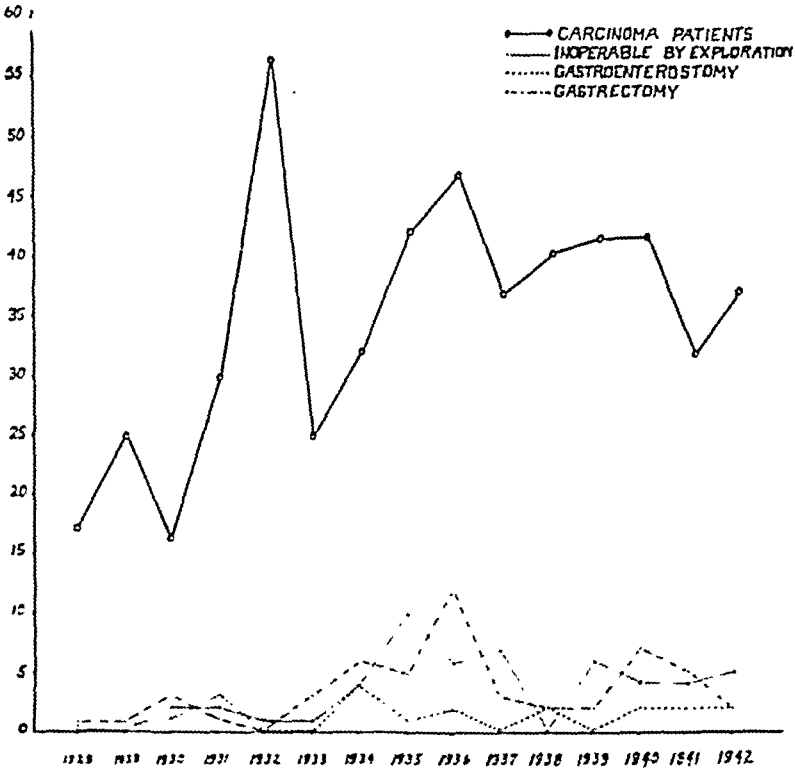


FIG. 4. Trends in treatment at Receiving Hospital.

Gastro-enterostomy was performed in forty-nine patients or 10.8 per cent of the series with an operative mortality rate of

RECEIVING HOSPITAL  
During this corresponding fifteen-year period there were 516 patients treated for

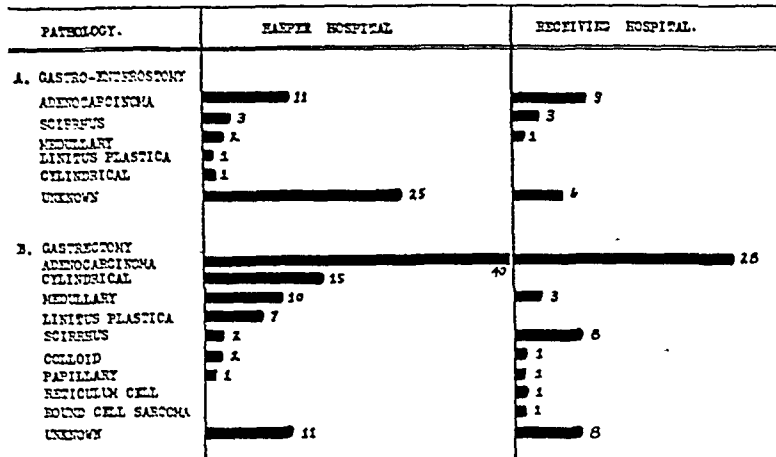


FIG. 5. Pathological diagnosis following gastro-enterostomy and gastrectomy.

39.0 per cent. Figure 2 shows that there has been no change in the popularity of this operation. An attempt should be made by the surgeon to obtain a pathological specimen either of the mass when the stomach is opened or a metastatic nodule or regional lymph gland. Of the biopsies taken the most common diagnosis was adenocarcinoma. The mean age of this group of patients was sixty years of age. The average duration of symptoms before operation was found to be seven months.

Gastrectomy was employed in eighty-eight cases or in 19.4 per cent of all the patients admitted to the hospital for this disease. The mortality rate for this operation was extremely high, being 64.7 per cent. There was a marked improvement in the mortality rate during the years 1941 and 1942 when twenty gastrectomies were performed with a mortality rate of 29.0 per cent. There has been a steady slow increase in the number of gastrectomies performed during these years as is shown in Figure 2. The mean age of this group was fifty-six years and the average duration of symptoms before operation was six months. Again the most common pathological diagnosis was adenocarcinoma followed by cylindrical cell and medullary carcinomas. There were seven lesions diagnosed as linitus plastica.

carcinoma of the stomach at Detroit Receiving Hospital, an annual admission of thirty-four cases. There were 399 males and 117 females, a ratio of 3 to 1. The average age for the series was fifty-four years, with age extremes of sixteen and eighty-seven years; 395 patients or 76.6 per cent of all gastric malignancy cases were clinically inoperable and the hospital mortality rate for this group of patients was 48.1 per cent which is extremely high. This dismal picture is the result of the low social station of these people in which the patient does not consult the doctor early enough in his disease. Therefore, of four patients who enter the hospital for cancer of the stomach, three are clinically inoperable and of these two die in a relatively short time without benefit of surgery.

There were only 121 patients submitted to surgery which is 23.4 per cent of all the cases. The operative mortality rate for all patients undergoing surgery was 39.6 per cent, a figure which in itself is lower than at Harper Hospital. Exploration revealed that another fifty-one patients had an inoperable lesion, leaving only seventy patients to benefit from either palliative or curative surgery. The mortality rate in the patient found to be inoperable by exploration was 17.6 per cent.

Gastro-enterostomy was performed in nineteen cases, or 3.7 per cent of the entire series. The mortality rate for this oper-

terostomy or gastrectomy at both hospitals was collected and set down in Table III. As one can see these patients fell entirely

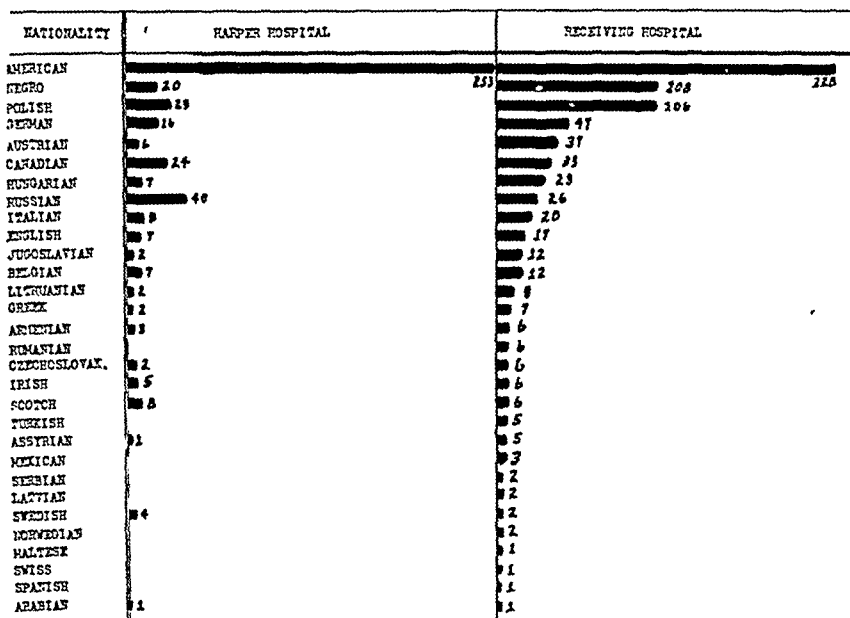


FIG. 6. Carcinoma of stomach by nationality, 1928-1942.

ation was 52.7 per cent. Figure 4 reveals that there is no marked change in the use of this operation. The mean age of the patients submitted to gastro-enterostomy was fifty-four years and the average duration of symptoms was 4.8 months.

Gastrectomy was performed in fifty-one patients or 9.8 per cent of the series which again is a low percentage, but when compared to the number of gastro-enterostomies indicates a real appreciation of the value of attempting curative surgery. The mortality rate for this operation was 57.0 per cent or somewhat better than at Harper Hospital. Of the specimen studied, the most common diagnosis was adenocarcinoma. The average age of the patients undergoing gastrectomy was fifty-six years and the average duration of symptoms of the disease was 5.2 months. The youngest subject, a boy of sixteen years of age, had a subtotal gastrectomy for a round cell sarcoma.

The symptom incidence for all patients who were operated upon by gastro-en-

tero into the group presenting the "late symptom complex" associated with late carcinoma of the stomach.

TABLE II  
SYMPTOM INCIDENCE  
207 Operated Patients

Symptom	Incidence
Pain.....	158
Weight loss.....	152
Vomiting.....	113
Fullness.....	83
Mass.....	17

Data concerning the blood counts and gastric analysis were collected from the charts of this same group of patients and entered in Table IV. Interestingly enough, approximately one-fourth of these patients had a normal blood picture. Likewise 116 patients or 56.0 per cent of the group had no gastric analysis reported. Twenty per cent of the patients had a normal hydrochloric acid content of the stomach.

The distribution of the patients with gastric malignancy according to their nationality, as shown in Figure 6, revealed

a suprisingly high incidence of carcinoma in the negro race. The negro is prone to develop tumors from structures of mesodermal origin and more rarely develops tumors from structures of ectodermal and entodermal origin. Boyce,<sup>3</sup> reporting on carcinoma of the stomach from Charity Hospital in New Orleans, and Rippy<sup>4</sup> also

TABLE III  
AGE INCIDENCE AND DURATION OF SYMPTOMS  
Operable Cases, 1928-1942

	Harper Hospital	Receiving Hospital
A. Gastro-enterostomy.	49 cases	19 cases
Mean age.....	60 years	54 years
Age extremes.....	37 to 88 years	32 to 73 years
Duration of illness..	7 months	4.8 months
Sex incidence.....	30 M.; 19 F.	19 M.; 0.0 F.
B. Gastrectomy.....	88 cases	51 cases
Mean age.....	56 years	56 years
Age extremes.....	30 to 78 years	16 to 80 years
Duration of illness..	6 months	5.3 months
Sex incidence.....	59 M.; 29 F.	44 M.; 7 F.

TABLE IV  
INCIDENCE OF ANEMIA AND ACHLORHYDRIA  
207 Operable Cases

Laboratory	Incidence
A. Anemia	
Normal.....	52
Moderate.....	46
Severe.....	72
Unknown.....	37
B. Achlorhydria	
Present.....	41
Absent.....	50
Unknown.....	116

found the incidence disproportionately high and Boyce postulated that this was due to their low threshhold of sensitivity. In this series the northern European showed a higher incidence of cancer of the stomach than did the southern European.

SUMMARY

1. There is no marked annual increase in the admissions for cancer of the stomach to either Harper or Receiving Hospitals.
2. The percentage of clinically inoperable patients with cancer of the stomach was 42.3 per cent at Harper Hospital and 76.6 per cent at Receiving Hospital.
3. Fifty-seven per cent of all cases of gastric malignancy admitted to Harper Hospital were submitted to surgery in contrast to only 23.4 per cent at Receiving Hospital.
4. At Harper Hospital gastro-enterostomy was performed in 10.8 per cent of the entire series of patients while at Receiving Hospital only 3.7 per cent were treated thus.
5. Gastrectomy was performed in 19.4 per cent of the cases at Harper Hospital and in 9.8 per cent of the patients at Receiving Hospital. The mortality rate for gastrectomy at Harper Hospital during 1941 and 1942 was 29.0 per cent, a marked improvement over other years.
6. Finally, no evidence was found to indicate a marked improvement in either diagnosis or treatment of early carcinoma of the stomach during this fifteen-year period.

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# OSTEOGENIC OSTEOLYTIC SARCOMA OF THE OS PUBIS

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**O**STEOGENIC sarcoma in general is an unusual disease. Osteogenic sarcoma involving the pubic bone is extremely rare. In several large series of cases of osteogenic sarcoma which were studied and reported by Meyerding and Valls,<sup>7</sup> Coley and Coley,<sup>11</sup> Ewing,<sup>25</sup> Geschickter and Copeland,<sup>28</sup> no case was reported as attacking the os pubis.

The only authenticated cases which I have been able to discover in the literature are those of Shoemaker and Robertson,<sup>18</sup> who reported the tumor on the left pubis and adjoining ischium and that of Campbell<sup>5</sup> which also involved the ischium and pubis. In the latter instance, the diagnosis was made on clinical and roentgenographic findings; no biopsy was performed. Two questionable cases, without the benefit of histologic examination, are those recorded by De Brun, in 1881,<sup>22</sup> and by Picque, in 1894.<sup>42</sup>

## DIAGNOSTIC CRITERIA

**Age.** Osteogenic sarcoma is a disease of youth rather than old age. It is very unusual in those over fifty years. The average age in the series reported by Meyerding and Valls<sup>38</sup> was 29.3 years.

**Sex.** The ratio of male to female is approximately 2 to 1 (Meyerding and Valls<sup>38</sup>; B. L. Coley<sup>8</sup>).

**Trauma.** The incidence of trauma as an etiologic factor has been variously estimated at approximately 50 per cent by Meyerding and Valls<sup>38</sup> and B. L. Coley.<sup>9</sup> When one considers the great number of injuries which take place and the relatively small number of sarcoma which develop, one is inclined to dismiss injury as an exciting factor. This is the stand taken by Ewing<sup>25</sup> who believes that the cause is

probably a disturbance in the intrinsic growth factors.

**Pain.** The pain associated with this condition is characteristic. It may precede recognition of the disease by a few weeks or by many months. At first it may be intermittent, but it soon becomes constant and is intensified at night. The pain due to sarcoma is aggravated by traction in contradistinction to that of inflammation which is usually alleviated by traction (Campbell<sup>4</sup>).

**Swelling.** Swelling is a sign which may appear early if the lesion is superficially placed. If deeply seated, it appears late.

**X-ray.** The x-ray findings are sufficiently distinctive to enable the roentgenologist to make the diagnosis. The lesion involves the ends of the long bones as a rule. It is located in the ends of the diaphysis, may invade the epiphysis, but rarely involves the joint. The bone shaft is in the center of the tumor and radiating spicules of bone are evident. The latter are indicative of osteoplastic reaction.

**Pathologic Fracture.** Pathologic fracture occurs in almost one-half of the cases of osteogenic sarcoma (Bloodgood and Geschickter<sup>2</sup>).

**Microscopic Findings.** Biopsy, either open or closed, is an invaluable aid in making the diagnosis. Microscopically, osteogenic sarcoma is a malignant tumor arising from tissue predestined to form bone producing cells. The chief feature in the structure of osteogenic sarcoma is the production of immature and atypical bone, cartilage, and osteoid tissue by pleomorphic tumor cells. The cells are hyperchromatic, spindle, rounded, and polyhedral. Some of the blood vessels are the normal vessels of the affected tissue, while others are the tumor

blood vessels, lined by tumor cells, thus giving rise to metastases. Giant cells form from the overgrowth or fusion of tumor

right inguinal region. Pain was present on motion of the right thigh in all directions, but there was no limitation of motion in any direc-



FIG. 1. X-ray taken on admission to hospital; arrows indicate site of lesion.



FIG. 2. X-ray taken three months after biopsy; arrow shows pathologic fracture which is still present.

cells. Foreign body giant cells may be present and may form the basis for an erroneous diagnosis of benign giant cell tumor (Ewing<sup>25</sup>). Osteogenic tumors possess the property of osteolysis and osteogenesis in varying degrees. Either the destructive or productive feature may almost wholly predominate.

*Serum Phosphatase.* Serum phosphatase (alkaline) is associated with bone formation. The higher the phosphatase content of the blood serum, the worse is the prognosis in osteogenic osteolytic sarcoma since it connotes greater activity.

#### CASE REPORT

The patient, a white woman, forty-two years of age, employed as an office worker, was admitted to the Jewish Memorial Hospital on March 16, 1940, complaining of pain in the right groin which radiated along the anterior and inner aspects of the right thigh. This symptom had been present for six months. At the onset it was intermittent in character, but three weeks prior to admission it had become constant and much more intense. Standing and walking aggravated the pain. There were also complaints of frequency of urination and nocturia. The patient had lost nine pounds in weight.

Examination revealed a well nourished and well developed white woman. There were no significant findings in the head, neck, chest, or abdomen. Slight tenderness was found in the

tion. Swelling and redness were absent. The urine examination was negative, and the blood count was normal. A lesion of the right pubic bone was suspected and this suspicion was verified by x-ray.



FIG. 3. X-ray taken two and one-half years later.

Roentgenograms taken two days after admission were reported upon as follows: the plates "reveal no gross abnormalities of the lower portion of the pelvis and hip joints. The right horizontal ramus of the pubic bone shows extensive destructive changes. Examination of the skull, skeletal structures and spine, and also blood serum studies would help to differentiate between giant cell neoplasm and malignant infiltrations of the pubic bone. If no further light on this destructive bone lesion can be ascertained, would suggest biopsy for diagnosis." (Figs. 1, 2 and 3.)

In accordance with the roentgenologist's suggestion, further studies were made:

"Roentgenographic examination of the skull, thorax, and lumbo-sacral spine exhibit no evidence of any osseous destruction. Moderate

The patient made an uneventful recovery and was discharged from the hospital on April 21, 1940, approximately five weeks after

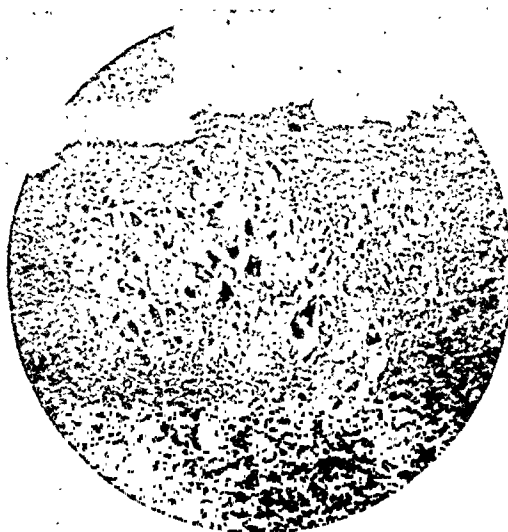


FIG. 4. Section of tissue removed at biopsy.  
× 135.

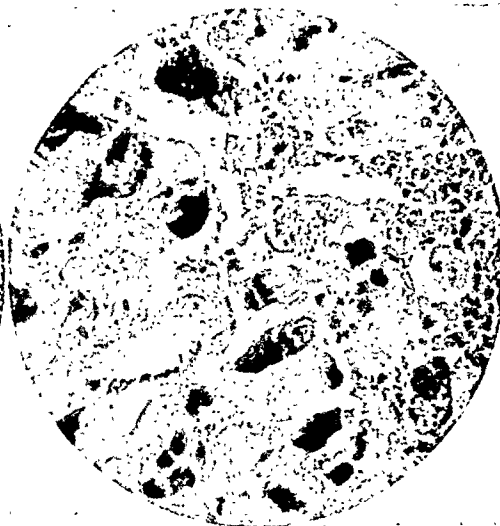


FIG. 5. Section of tissue. × 600.

hypertrophic, osteoarthritic changes are present in the lower dorsal vertebrae. Extensive bone changes are again discerned in the horizontal ramus of the right pubic bone and have the appearance of a giant cell tumor. However, malignancy can only be ruled out by biopsy."

Blood serum studies revealed the following pertinent findings:

Serum calcium.....	11.2	(normal 9-11)
Serum phosphorus.....	4.5	(normal 3-4)
Serum phosphatase (alkaline) .....	18 units	(normal 1.5-4)

The phosphatase is markedly elevated and this is what one would expect with extensive bone destruction. The urine examination for Bence-Jones protein was negative.

In view of all the facts, it was decided to perform a biopsy. It was quite evident from the roentgenograms that even though the lesion present should prove to be a malignant growth, radical surgery would be out of the question because of the location and the extent of the lesion. The procedure was to expose the body and the right superior ramus of the pubic bone. A portion of the cortex of the superior ramus, about one inch long, was removed and as much as possible of the medulla was curetted. A specimen was also taken from the body of the pubis.

admission. She was readmitted eleven days later for a pelvic abscess which pointed through the right lateral vaginal wall. It was incised and drained and the patient was discharged one week later.

Roentgenograms taken three weeks after operation and after radiotherapy revealed no change from the previous observations except for a fracture at the medial extremity of the superior ramus of the pubic bone. This fracture was undoubtedly pathologic in nature since the degree of trauma incurred during the operation would not have produced a fracture in normal bone.

Microscopic examination of the removed bone made by Dr. Alfred Angrist showed "large fragment of rather anaplastic tumor tissue consisting of a great variety of cells. Predominant are large polyhedral cells of almost giant measurements showing excessive variation in size and shape. The nuclei of these cells likewise show considerable variation. Some of them are vesicular, others pyknotic. Mitotic figures are frequent. Other cells have several pyknotic nuclei suggesting giant cells. There is definite pleomorphism present. In some areas, spindle cells are seen. In other areas, vesicular closely placed cells suggesting early cartilaginous structure are present. Osteoid tissue is seen in some areas. Some hemorrhage and inflammatory reaction with signs of old hemorrhage in the form of pigment phagocytes

is noted. The diagnosis is anaplastic sarcoma suggesting an osteolytic osteogenic intramedullary tumor." This diagnosis was confirmed after additional studies of decalcified and specially stained material were made to rule out malignant variety of giant cell bone tumor, striated muscle tumor, and tumor of fat origin. (Figs. 4 and 5.)

In the thirty-one months that have elapsed since the patient was operated upon, she has received several courses of deep roentgen ray therapy (dosage: 6800 R in all). Yet, judging from the x-ray findings, there has been little appreciable change in the lesion. The last x-ray, taken on November 14, 1942, "discloses no essential change in the appearance of the lesion in the right ramus of the pubis. No further destruction is noted. There is sclerosis around irregular rarified areas with expansion of the bone and encroachment on the obturator fossa."

Symptomatically, however, there is a marked improvement. The patient has no pain or discomfort whatever, no tenderness or disability. She is able to walk and stand without the pain she suffered prior to her admission to the hospital. She has regained the nine pounds previously lost; in fact, her weight now is greater than it has ever been. She works at her usual occupation without any difficulty.

#### COMMENTS

The diagnosis of osteogenic sarcoma is made after careful consideration of history, physical examination, roentgenogram and biopsy. The first two factors have already been sufficiently considered. Probably overshadowing their importance is that of the roentgenogram. It is very frequently the deciding factor in the diagnosis. Ewing<sup>24</sup> considers it of more importance than a biopsy. He believes that, in general, the roentgenologist is better able to make the diagnosis than the pathologist. The histologic characteristics of bone tumors vary greatly depending upon the particular portion of the tumor biopsied.

There seems to be some difference of opinion as to the type of biopsy which should be performed. Meyerding<sup>34</sup> favors the open biopsy. He believes that it offers little danger if carefully done. Ewing,<sup>24</sup>

on the other hand, is opposed to it on the grounds that hemorrhage, accelerated growth and metastases may result. He believes that local variations in tumor tissue are often misleading. In his opinion, the diagnosis should be made easily on the clinical and roentgenographic findings, especially the latter.

However, he does concede that an aspiration biopsy is permissible since it avoids the mechanical dangers which he thinks are inherent in an open biopsy.

*Prognosis.* In the treatment of osteogenic sarcoma in general, it is commonly accepted that early radical surgery offers the best prognosis, but the results at best are rather poor. Some men precede or follow surgery with x-ray therapy. The most encouraging feature in the treatment of this condition is that since the diagnosis is now being made earlier, and treatment instituted much sooner, the percentage of cures (five-year) has considerably increased. At the turn of the century, it was about 2 per cent. In 1923, it was 16.5 per cent, and, at the present time, it is approximately 23 per cent (Coley and Pool;<sup>7</sup> Mayo Clinic<sup>36</sup>). This percentage of cured patients in the Mayo Clinic statistics is higher than that reported from most other clinics. Incidentally, it includes cures by all methods, i.e., amputation, excision, and radiotherapy.

*Treatment.* The treatment of choice is early, high amputation. This, unfortunately, is sometimes impossible, either because of the location, size or extent of the tumor, or because the patient refuses to permit a deforming operation. Excision of the lesion is frequently performed because more radical surgery is contraindicated. In some cases, again for the same reasons, only biopsy followed by radiation is the mode of treatment. This was the only possible procedure open to me in the case which is being reported.

In Meyerding's<sup>36</sup> series of cases, there are: 24.7 per cent five-year cures by amputation; 34.1 per cent five-year cures by excision with or without radiation; 9.1 per

cent five-year cures by biopsy followed by x-ray. The apparent contradiction in results from amputation and excision is due to the fact that many patients came to amputation after they have had more conservative measures tried without success. In other instances in which it is evident that cure is out of the question, amputation is performed as a palliative measure for the relief of intractable pain.

Those cases which are seen earliest after the onset of symptoms are usually the most malignant and, therefore, offer the poorest prognosis regardless of prompt amputation. This may explain Ferguson's<sup>26</sup> statement that early amputation offers a poorer prognosis than late amputation.

X-ray therapy alone offers a very poor prognosis (Codman<sup>20</sup>) and should be reserved for those cases for which more radical measures are refused or in which the location or extent of the lesion contraindicates any other treatment. Coley,<sup>9</sup> in a series of seventy cases treated only by x-ray, reported not a single five-year cure. Some men, among them Ewing,<sup>25</sup> have a preference for preoperative x-ray therapy followed by radical surgery. Ewing believes that the time spent in giving x-ray is not wasted and the danger of metastasis occurring during that interval is slight. There is the advantage, moreover, that it may aid in making the diagnosis which, in many cases, is not clear cut. If the growth responds well to x-ray therapy, it is, in all probability, not an osteogenic sarcoma. Roentgen therapy is frequently used postoperatively for pulmonary metastases, but here also the results in general are poor. Reports indicate that prolongation of life may be accomplished by this means (McReynolds;<sup>39</sup> Simmons<sup>44</sup>).

Coley's serum may be used, chiefly on empiric grounds. Today these toxins are little used. Bradley Coley<sup>9</sup> states that they may be of value in inhibiting the growth of pulmonary metastasis which he believes are present at the time of opera-

tion, but in such minute proportion as not to be demonstrable.

In the case under discussion, the only treatment available as has been stated, was deep x-ray therapy following biopsy because of the location and size of the growth. Since this form of treatment gives the poorest permanent results, it is gratifying that the patient still remains a happy, useful individual.\*

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\* Five months after this article was written the patient showed evidence of extension of the sarcoma from the pubic bone into the pelvis and of metastasis to the liver. Biopsy of the pelvic mass showed the same pathologic findings as the original biopsy. The patient went down hill very rapidly and died on October 17, 1943. No autopsy was obtained.

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A MENINGOCELE consists of a protrusion of a pouch of dura mater through a congenital defect in the skull. The usual situations are the root of the nose, over the occipital bone, or in connection with the anterior fontanelle. Very occasionally they appear through the base of the skull, in which situation they have been mistaken for nasal polypi, and attempted removal has resulted in fatal meningitis.

# OPERATIVE POSITION FOR ULNAR NERVE TRANSPOSITION

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NOT infrequently, operative positioning of a patient may mean the difference between prolonged for-

operator. The positioning of the patient, however, is extremely awkward in relation to the surgeon and his assistants.

FIG. 1.



FIG. 2.

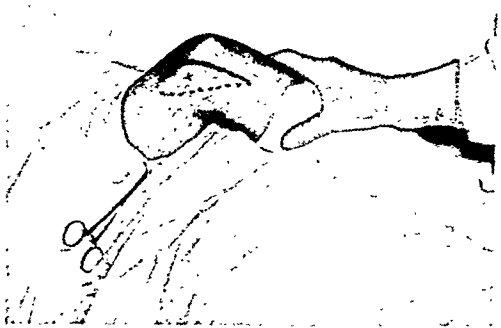


FIG. 1. Patient supine with arm in abducted manual traction.

FIG. 2. Patient supine with arm across chest and manually elevated shoulder extension.

midable and easily performed surgery. The operative technic for ulnar nerve transposition, is in itself a well established one and presents no problem to the gentle

As depicted in all photographs, the continuous curved line represents the incisional site, the x, being the medial epicondylar prominence of the humerus,

and the interrupted line, the area where the nerve is to be re-routed.

Figures 1 and 2 demonstrate those

relaxed extremity. It is a physical impossibility for any one to maintain this position for more than several minutes



FIG. 3.



FIG. 4.

FIG. 3. Patient prone with arm internally rotated.

FIG. 4. Represents a more detailed view of Figure 3, with the supporting mechanism of the pillow resting on a slight arm board extension from the side of the operating table, with the dorsum of the hand and wrist resting in the lumbar hollow.



FIG. 5. View of the facilitated proximity to the operative site without necessity of continued manual support of the extremity during the surgical procedure.

positions generally adhered to. The patient is supine and one assistant must remain in a steady position, exerting constant traction and firm purchase on a completely

at a time, and then not without considerably annoying, though unavoidable, "wobbling." A second assistant is therefore necessary to aid with the actual procedure,



and even he is unable adequately to approach the operative field to be fully advantageous.

Figure 3 demonstrates the operative position of a patient for ulnar nerve transposition adhered to at the Station Hospital, Camp Reynolds, Pennsylvania. The patient is prone and the arm internally rotated, resting the dorsum of the hand on the small of the back.

Figure 4, viewed from above downward, demonstrates the details of the resting mechanism, with the supporting pillow and arm board projection.

Figure 5 demonstrates the comfortable proximity of the surgeon to the operative field.

Hence a delicate procedure can be gracefully performed, under direct vision, firm steadiness and with greater precision.

#### SUMMARY

An improved method of operative positioning of a patient for ulnar nerve transposition is described. It lends itself admirably in any procedure requiring approach to the mesial aspect of the elbow.



CIRROID aneurism is a rare condition, but of importance owing to difficulty in treatment. It is due to dilatation of the arteries, which open more or less directly into venous spaces. Capillary naevi are sometimes seen in the overlying skin.

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# Case Reports

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## INTRATHORACIC GOITER\*

### CASE REPORT

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**A**LTHOUGH substernal goiter was first described anatomically as far back as 1749 by Haller and clinically by Lingl in 1830, it was not generally recognized before 1899, when Schieff demonstrated the value of the roentgenogram in its diagnosis. The symptoms are usually vague, dyspnea often being the only complaint.

Today, with all facilities available, differential diagnosis is still difficult. Roentgenograms will usually demonstrate a tumor mass; but differential diagnosis must be made from sacculated aneurysm of the ascending arch of the aorta, persistent thymus, lymphosarcoma, Hodgkin's disease and forms of mediastinal tumor, especially dermoid and less frequently echinococcic cysts. Calcareous deposits should suggest a dermoid cyst but calcified areas are sometimes present in goiter and may occasionally be seen on a "bucky." In lymphosarcoma and Hodgkin's disease, treatment with x-ray will usually cause a regression of the tumor mass. It is our opinion that, even after careful and prolonged examination, diagnosis can only infrequently be made except by exploration.

Substernal goiters may be partial or complete, fixed or mobile. Such nomenclature as "wandering goiter," "spring goiter" and "goiter mobile" has been applied to the mobile type of substernal goiter.

That the partially substernal goiter is not an unusual condition is readily ap-

parent from our own statistics. In our group of 15,000 thyroidectomies performed in the past twenty-five years, 15 per cent fell into this category. Completely substernal or intrathoracic goiters, on the other hand, are extremely infrequent. It is difficult to estimate from the literature the true incidence of this condition, as every surgeon differs in his definition of intrathoracic by degree.

In our last personal series of 1,000 thyroidectomies only three were completely intrathoracic. It is of interest that all three cases proved to be adenomas, thus further confirming the general belief that intrathoracic goiters originate from adenomas or adenomatous goiters.

One of the cases of intrathoracic goiter was an adenoma which was continuous with the left lobe of the thyroid and which was possible to remove through a low collar incision of the neck. This adenoma measured 10 cm. in length and 7 cm. in diameter.

In the second case the goiter was removed by splitting the sternum. Although it was not as large as in the first case, it was very adherent to the surrounding structures.

In the third case, which we are presenting in detail, the goiter was the largest yet reported and was entirely intrathoracic, being connected to the trachea in the neck by only a thin fibrous band. In fact we think it might be considered an ectopic or aberrant thyroid. When removed it measured 15 cm. in length,

\* From the Department of Surgery, DeCourcy Clinic, and the Good Samaritan Hospital.

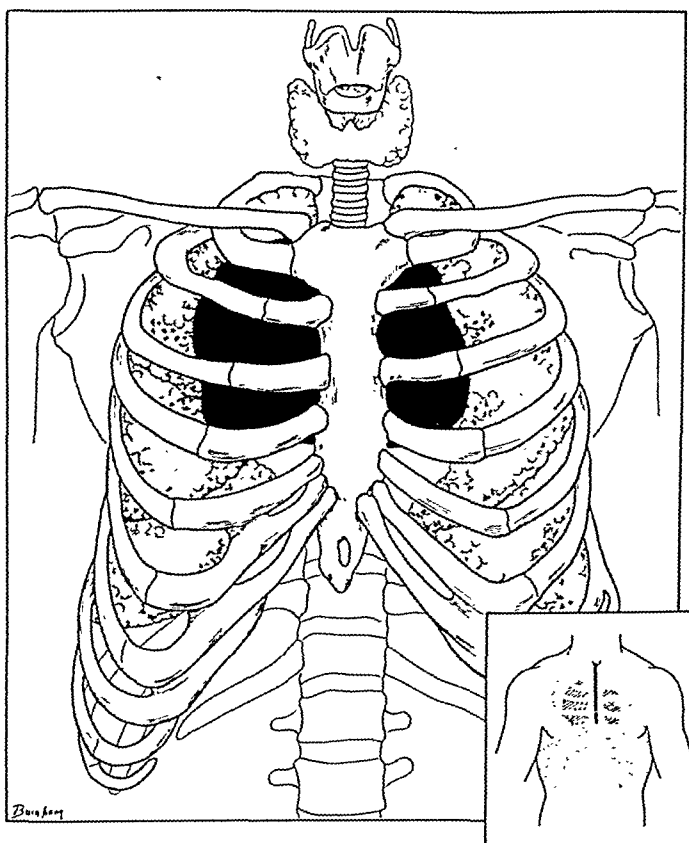


FIG. 1. Appearance of tumor within thorax. Insert shows incision of sternum.



FIG. 2. Anteroposterior view showing deviation of trachea.



FIG. 3. Lateral view.

11 cm. in diameter and 8 cm. in depth, the largest intrathoracic goiter yet reported to my knowledge.

#### CASE REPORT

E. F., a male, aged forty-nine, weight 196 pounds, was seen at the clinic on May 15, 1943. He complained of dyspnea, occasional pains in the back and occasional epigastric distress. There were no other symptoms. When first distressed with dyspnea a year previously, he had consulted a physician who had prescribed some pills. While under this treatment he lost forty pounds in weight. He consulted another physician, who after examination advised x-rays of the chest. Roentgenograms revealed a tumor mass. X-ray treatments were then instituted. During this time he felt better and regained the forty pounds in weight. Follow-up roentgenograms, however, failed to show any regression of the tumor.

On examination at the DeCourcy Clinic, the patient, a barrel-chested individual, had a systolic blood pressure of 150, diastolic 100; pulse was 88; temperature 98.4°F. Urinalysis revealed specific gravity of 1.010, acid reaction, negative chemically. On microscopic examination, there was an occasional red blood cell, 10 pus cells per high power field and an occasional epithelial cell. Examination of blood showed hemoglobin of 88 per cent, red count of 4,580,000 and white count of 7,000. Differential was essentially normal. Wassermann and Kahn tests were negative.

X-ray of the chest showed a thickened pleura over the right lung. Lung fields and pleura were otherwise clear. A very large tumor mass could be visualized in the region of the mediastinum, extending both to the right and left. This suggested an aneurysm of the aorta; the heart outline was not enlarged.

X-ray of the gallbladder was taken on May 21st. The roentgenologist reported that the gallbladder was not visualized and advised another examination. X-ray of front and side views of chest taken on this date showed a large, well circumscribed shadow of increased density in the upper anteriomediatinum, which displaced the trachea backward and to the right. It appeared to be continuous with the arch of the aorta and therefore suggested the presence of a large aortic aneurysm. The heart outline was not enlarged.

On June 12th, further x-ray of chest showed the same findings as previously described. There were no changes.

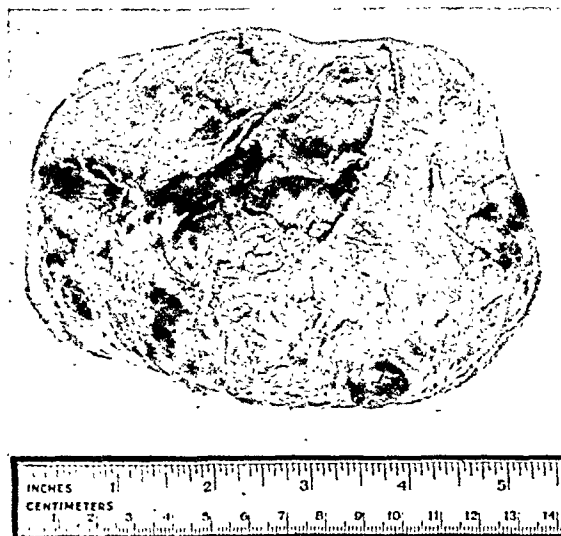


FIG. 4. Tumor after shrinkage, 13.5 by 11 by 8 cm.

Repeated fluoroscopic examinations, however, failed to convince us of the diagnosis of aneurysm. More deep therapy was applied but there was no regression.

Believing that we might be dealing with an intrathoracic goiter, 10 drops of Lugol's solution were given three times daily for ten days. The patient entered the hospital on June 30, 1943. The thyroid in the neck was not palpable.

On July 3, 1943, operation was performed under nitrous oxide and oxygen anesthesia. A low collar incision was made over the neck, which was very short, the thyroid cartilage being only 1 inch above the sternal notch. The left lobe of the thyroid could not be found and the right lobe was very small and flattened against the trachea. No nodules were palpable.

As the finger was inserted beneath the sternum, the upper border of the tumor could be palpated. The sternum was then split lengthwise in its middle portion down to the xiphoid. The electric circular saw and chisel and hammer were used. Where the halves of the sternum were separated, an exposure of about 2½ to 3 inches was obtainable. The tumor was seen lying beneath in the midline with the pleura thickened and pushed downward by the tumor.

Enucleation was started and it was thought that an easy removal would be effected; however, the adhesions became very dense where attached to the pericardium. Bleeding became profuse and necessitated stopping the operation and packing about the mass with hot moist

packs. A transfusion was added to the intravenous glucose solution and the patient was returned to bed.

15 cm. by 11 cm. by 8 cm., situated in front and to the left of the trachea which was compressed. The lateral and anterior sides of the

FIG. 5.

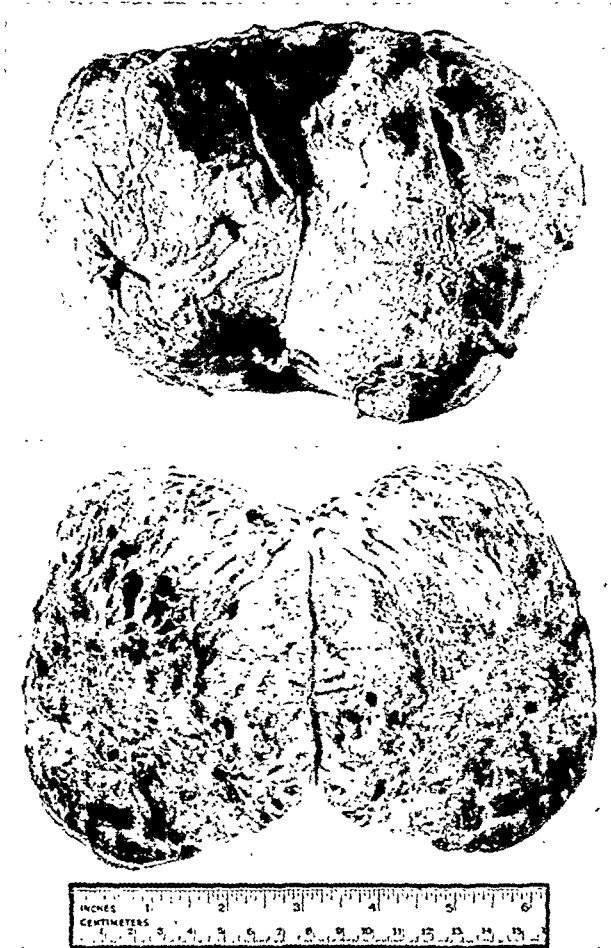


FIG. 6.

FIG. 5. Tumor showing tracheal groove and previous attachment to pericardium.

FIG. 6. Tumor halved longitudinally.

Twenty-four hours later the patient was sitting up in bed talking. Active bleeding had stopped; pulse was 90 and of good volume; respirations were 28; temperature was 102°F. per rectum. Twelve hours later (thirty-six hours postoperatively) the temperature rose to 108°F. Respirations became quickened and labored, the pulse rapid, and the patient expired.

At autopsy the thorax was opened in the usual manner, by extending the midline incision and making a horizontal incision from the shoulders to the superior portion of the operative incision. Behind the sternum and ribs, there was an encapsulated tumor mass, about

mass were closely related to the lungs and pleuras. The lateral and inferior sides were related to the pericardium which was shoved to the left. The superior side was related to the sternum and clavicles. Thyroid lobes were thin, atrophic and compressed by the tumor mass, which weighed 655 Gm. and was removed in its entirety. Cut sections showed fibrosis and small cysts. The left lung weighed 610 Gm., the right lung 650 Gm.; both showed hypostatic congestion and mild anthracosis, otherwise negative. The heart weighed 350 Gm. and was negative. Coronary arteries showed no pathological condition and there were no pathological changes of the aorta.

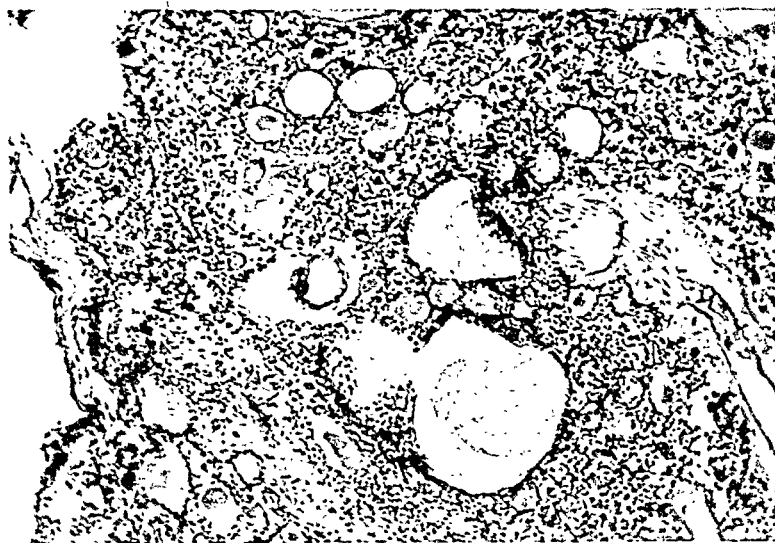


FIG. 7.



FIG. 8.



FIG. 9.

FIG. 7. Architecture is that of fetal adenoma.  
 FIG. 8. Hyaline degeneration and hemorrhage.  
 FIG. 9. Areas of fibrosis; slight infiltration of lymphocytes.

The pathological report was as follows: Anatomical diagnosis: (1) substernal adenoma of thyroid. Microscopic Diagnosis: (1) substernal fetal adenoma of thyroid; (2) lobular pneumonia.

#### COMMENTS

Whether this patient died in a thyroid crisis or whether the hyperthermia was terminal we are not prepared to say. Our impression was that it was a respiratory rather than a thyroid death.

The difficulty of differential diagnosis is again emphasized in the case reported.

The present day classification of intrathoracic goiter is vague. Descriptive terms such as substernal, retrosternal and subclavicular add to the confusion. We would suggest classifying all of them as intrathoracic. Further explicit description could be obtained by expressing to what degree the thyroid is submerged in the thoracic cage. For instance, if one-third of a lobe were intrathoracic, it might be called

intrathoracic goiter "first degree." If two-thirds of the goiter were intrathoracic, it might be termed "second degree." This would facilitate reporting these cases and give us a better statistical approach as to their respective occurrence.

#### SUMMARY

1. The incidence of completely intrathoracic goiter is extremely infrequent, only three cases occurring in our last series of 1,000 thyroidectomies.

2. A case report is presented with operative and necropsy findings.

3. The difficulty of differential diagnosis is emphasized.

4. Simplification of descriptive nomenclature and a system of classification as to the degree of submersion of the thyroid in the thoracic cage are suggested. This would facilitate reporting cases of intrathoracic goiter and would offer a better statistical approach for future reference.



# ADVANCED CANCER OF THE FACE\*

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THIS case is reported because of a successful result achieved in what appeared originally to be a hopelessly advanced case of basal cell carcinoma.

## CASE REPORT

W. K., No. 22603, a white male, painter, aged fifty years, was admitted to the Tumor Clinic of the New York Post-Graduate Hospital, stating, that about three years ago he developed a small ulceration at the inner canthus of the left eye for which he received radium treatment elsewhere. The lesion apparently cleared up, and he was discharged as cured. Because of economic reasons the patient did not apply for treatment when the lesion reappeared until it reached the present proportion. (Fig. 1A.)

Examination showed an extensive, excavated basal cell carcinoma, involving the left orbital region, destroying the left eye, both lids (Fig. 1C) and infiltrating the inner canthus of the right eye. (Fig. 1B.) The tumor was fixed to the underlying bone structure, and had broken into the frontal and to the left maxillary sinuses.

The patient was presented before the Tumor Conference whose consensus of opinion was that because of the advanced condition a radical attempt at electrosurgical removal should be made. The patient was then referred to the author by Dr. William F. MacFee.

After a routine preoperative preparation the operation was performed July 1, 1937, under general anesthesia. The lesion was first circumscribed by coagulation-cutting current through the healthy tissues about 2 cm. from the tumor edge. Bleeding was controlled throughout the whole operation by coagulation. The tumor mass was then coagulated with a flat electrode and the coagulated tumor was removed piecemeal by an electric cutting loop.

The tumor at the right canthus was carefully removed in similar fashion, avoiding damage to

the lacrimal duct. As the new growth involved the nasal bones and part of the frontal bones, it was necessary to coagulate and remove these involved structures. The left frontal sinus, as well as the left maxillary sinus, was invaded by the tumor which extended also into the anterior ethmoidal cells. These were coagulated and removed. The contents of the left orbit were enucleated, including the periosteum. When it was believed that the eradication of the tumor was complete, the wound surface was superficially desiccated with an electric plate and the cavity loosely packed with vaseline gauze sprinkled with boric acid powder. The patient left the operating room in good condition.

Postoperatively there was only a slight rise in temperature, little pain and no other complaint. Convalescence was uneventful. The patient was out of bed on the fourth day and was discharged to the surgical clinic twelve days after the operation, at which time the wound was clean and covered with healthy granulations. Some areas of the frontal bone and orbital portion of the zygoma, affected by coagulation, had begun to sequestrate. (Figs. 2A and B.)

On July 30th, the patient was readmitted to the hospital for plastic repair. The previously operated areas were carefully débrided of excess granulation and the frontal and maxillary sinuses were again curetted and additional bits of bone and soft tissue removed for further microscopical examination, in an effort to be reasonably certain that all the tumor had been eradicated.

A pedicled forehead and scalp flap containing the temporal artery, with a hairy portion to replace the eyebrow, was prepared from the temporofrontal region (12 by 10 cm.). The right canthus was reconstructed after a Thiersch graft from the thigh was sutured to the under-surface of the skin flap to replace the missing mucous membrane of the nose. The denuded area on the parietal and temporal region was covered with a skin graft from the thigh. The

\* From the Tumor Clinic, Department of Surgery, New York Post-Graduate Medical School and Hospital, Columbia University. Presented before the Section of Ophthalmology, New York Academy of Medicine, May 20, 1940.





FIG. 1. A, extensive recurrent basal cell carcinoma of nose, cheek and orbit with involvement of the paranasal sinuses; B, lateral view, showing right inner canthus and lids involved; C, lateral view showing involvement at the left side.



FIG. 2. A, three weeks after coagulation, the wound was covered with healthy granulation, excepting bones affected by coagulation; B, lateral view of defect resulting after radical operation. Remnants of the frontal, ethmoidal and maxillary sinuses can be seen.



FIG. 3. Pedicled temporal flap containing the temporal artery, with a hairy portion to replace left eyebrow, covers the defect. Denuded temporal area was covered with skin grafts.



FIG. 4. A, pedicled flap divided and restored; final result; B, final result, left lateral view; C, final result, right lateral view.

nose was loosely packed with vaseline gauze. The skin flap, which was sutured to the defect by interrupted black silk sutures, did not show any discoloration on the application of a loose head bandage. Recovery was uneventful. The patient was discharged on the seventh day after this operation. (Fig. 3.) The revision and final stage was undertaken three months later under local anesthesia. The pedicle flap was divided and the residual portion restored to its original location. (Figs. 4A, B and C.) The postoperative course was uneventful. The patient was discharged to the clinic on the third day after the operation. He had been hospitalized for twenty-one days.

The pathological examination, No. 15944-73392, showed basal cell carcinoma with considerable growth activity. Specimens from the second operation showed only granulation tissue.

The patient has been well since the operation; he has had no complaints and there is no evidence of recurrence over a follow-up period of six years. A prosthesis was subsequently made by Dr. Alexander Sebo to replace the lost eye. (Fig. 5.)

There is some retraction of the left nostril for which correction was refused by the patient.

This case is presented to demonstrate the effectiveness of a radical operation by electrosurgery followed by plastic reconstruction. Electrocoagulation has in our experience proved to be a satisfactory means of eradicating such advanced tumors.<sup>1</sup> The coagulated tumor tissue is readily differentiated from uninvolved tissue during this type of piecemeal removal. It is possible, therefore, to determine the extension of the malignant process and to remove enough surrounding uninvolved tissue to prevent recurrence. Such a procedure, in selected cases, has distinct advantages over classical resection, especially when the extension of the tumor cannot be determined with sufficient exactitude necessary for block resection.<sup>2</sup>

Plastic reconstruction was performed early for economic reasons, but only after

we had proved by biopsies that the tumor had been removed. We agree with other surgeons, who advocate reasonable delay



FIG. 5. Patient with artificial eye; no evidence of recurrence over a follow-up period of six years.

before plastic reconstruction in cases of recurrent and advanced cancer, to allow control of possible recurrences. In general a delay of six months to one year, with frequent biopsies from suspicious areas is practiced by us. Exceptions from this rule are permissible if a surgeon of sufficient experience has removed the tumor by wide excision through the uninvolved tissues far beyond its extension regardless of the consequent defect and disfigurement. However, if a tumor has extended close to vital structures and a wide radical removal is not possible, plastic repair had better be delayed.

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# NEUROFIBROMA WITHIN A LIPOMA OF THE NECK\*

## CASE REPORT

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AND

PETER MARCUSE, M.D.

Assistant Pathologist, Jefferson Davis Hospital

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THOUGH the presence of lipomas and neurofibromas in the same person has been reported (Adair, Pack and

female. Examination of the circulatory and respiratory system was negative. Neurological findings were normal, as were abdominal and

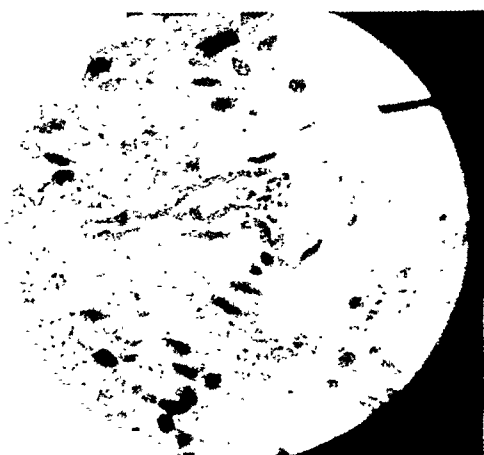


FIG. 1. High power view of a section taken from the structure in the center of the lipoma, showing fine, interlacing fibers and elongated cells with pointed processes (hematoxylin-eosin).

Farrior,<sup>1</sup> Alsberg,<sup>2</sup> Stout<sup>3</sup>), there seems to be no record of neurofibromatous tissue occurring within a lipoma. It seemed, therefore, justified to report the following case.

## CASE REPORT

The patient, a fifty-four year old, colored female, came to the Out-patient Department Surgical Clinic of Jefferson Davis Hospital because of a mass on the right side of her neck. She had always been in good health, but had had some fibroids removed several years ago. Nine years ago the patient noticed a soft nodule on the right side of her neck. This mass continued to grow slowly but never caused the patient any pain.

Physical examination revealed a well developed, well nourished, middle aged, colored

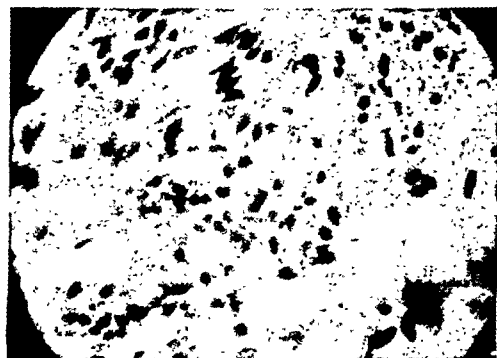


FIG. 2. High power view, showing character and arrangement of cells in the neurofibromatous tissue. Note palisading in the upper part of the field (hematoxylin-eosin).

pelvic palpation. The skin showed no lesions except for a nodule, approximately 1.5 cm. in diameter, located in the scalp of the occipital region, just to the left of the midline. This tumor was moderately firm, slightly movable against the underlying tissue, firmly adherent to the skin and non-tender. The main finding on physical examination, was a tumor, approximately 8 cm. in diameter, involving the right side of the lower neck and part of the right shoulder. This mass was soft, non-tender, movable against the underlying tissue, but not against the skin. The regional lymph nodes were not enlarged.

Routine laboratory examinations were essentially negative. A Kolmer and Kline test were negative. However, there was a report of a four plus Kline in 1939, since which time the patient had had antiluetic treatment.

The tumor of the neck was diagnosed as a lipoma and excision was performed. The gross description of the specimen was as follows:

"The specimen consists of an elliptical piece of colored skin, 6.0 X 2.0 cm. A mass of adipose

\* From the Surgical Division and the Department of Pathology, Jefferson Davis Hospital, Houston, Texas.

tissue, approximately 7.0 cm in diameter, is adherent to the skin. This mass is soft and friable, subdivided by fibrous septa, and is

fibroma in the center of a lipoma. Slides were also sent to Dr. William Boyd, Department of Pathology, University of Toronto, Canada,

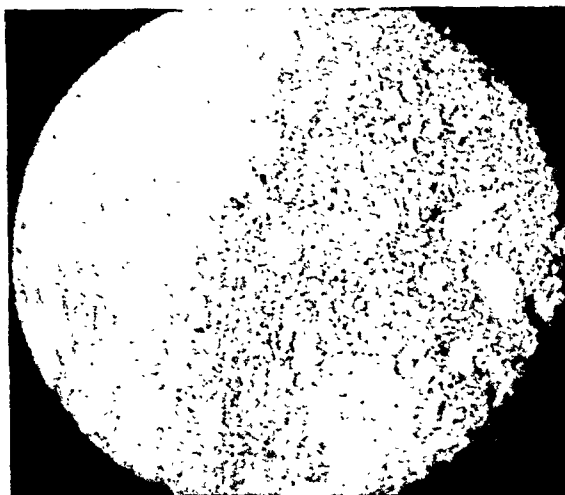


FIG. 3. Borderline between lipoma and neurofibromatous tissue (hematoxylin-eosin, low power).

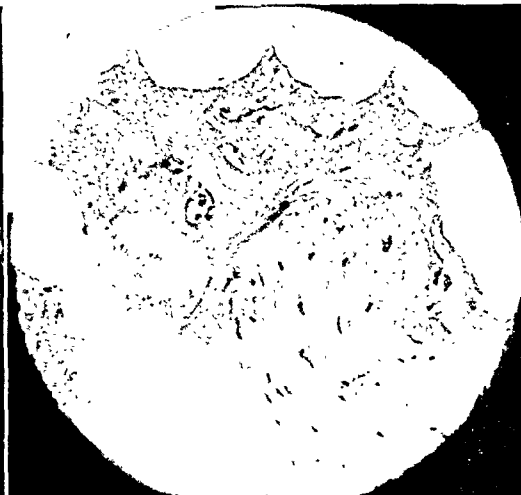


FIG. 4. Section from a lipoma of the axilla showing a branch of a peripheral nerve within a fibrous septum (hematoxylin-eosin, high power).

enclosed in a thin, translucent capsule. Cut surface is sulphur yellow, homogenous, except for a nodule, 1.0 cm in diameter, which is located in the center of the mass. This nodule is of moderately firm, non-friable consistency, appears light pinkish gray and homogenous. It is indistinctly delimited from the surrounding tissue and projects slightly above the level of the cut surface. The appearance of the skin is not remarkable."

Microscopic examination of the main mass showed a typical picture of adult fat. Sections taken from the nodule that was found in the center of the mass showed the characteristic appearance of a neurofibroma. There were numerous thin strands of interlacing fibers. Arranged between these were elongated, fairly regular cells with ovate nuclei and long pointed processes. (Fig. 1.) The cells were arranged in rows and in whorls and, in places, palisading was noticeable. (Fig. 2.) The nuclei were regular, fairly dark and there was no increased mitotic activity. The nodule was not encapsulated, and near its periphery the tissue was interspersed with fat cells. (Fig. 3.) Several well developed blood vessels were seen and the fibers and cells appeared arranged in a concentric manner around these vessels.

A block from the specimen was sent to Dr. A. P. Stout, Department of Surgical Pathology, College of Physicians and Surgeons, New York, who reported that this was a neuro-

who confirmed that the section showed neurofibroma intermingling with fatty tissue.

The small nodule from the scalp was removed later, and gross as well as microscopic examination proved it to be a sebaceous cyst.

The postoperative course was uneventful; the wound healed satisfactorily and there has been no evidence of recurrence for several months after the operation.

#### COMMENT

The tumor can be classed as a fibrolipoma, with the fibrous component being restricted to the center of the growth. This type of fatty tumor is rare. In Geschickter's<sup>4</sup> series of 622 lipid tumors there were eighteen cases of fibrous or embryonic lipoma.

In the case under discussion the fibrous element appears to be of nerve sheath origin. This brings up the interesting problem of a possible connection between lipoma and neurofibroma, and between lipoma and peripheral nerves, a question that is usually discussed with reference to multiple lipomas. As Ewing<sup>5</sup> says: "The occurrence of multiple symmetrical lipomas has suggested to many a connection with the peripheral nerves." Adair, Pack, and Farrior<sup>1</sup> also point out that lipomas and

neurofibromas have certain similarities and that association of lipomas with nerve fibers in the subcutaneous tissue has been observed.

Neurofibromas have been found with lipomas in the same case (Adair, Pack and Farrior,<sup>1</sup> Alsberg,<sup>2</sup> Stout<sup>3</sup>). However, even the authors who consider the two growths to be related have found no definite histologic evidence to prove the relationship (Hogue<sup>6</sup>). Moreover, all the observations were made with regard to neurofibromatosis and multiple lipomatosis and are not readily applicable to single tumors.

The case here presented shows that association of neurofibromatous with lipomatous growths can occur. Nerve fibers have been traced into lipomas (Alsberg<sup>2</sup>). A lipoma of the right axilla, removed from a thirty-four year old colored female at Jefferson Davis Hospital, also shows clearly small branches of peripheral nerves in the fibrous septa between the various lobes. (Fig. 4.) It appears possible that a neurofibroma might arise from one of these septal nerve branches without having any etiological connection with the lipoma. The location of the neurofibroma in the center of the growth and its indistinct delimitation is suggestive of a neurogenic origin of the lipomatous component but is no conclusive proof.

From the clinical point of view the case under discussion shows the importance of careful gross and microscopic examination

of all lipomas. Fibrolipomas are classed among the recurrent lipomatous tumors by Geschickter,<sup>4</sup> and even malignant change is not infrequently observed. The general tendency to consider lipoma an absolutely innocent tumor may easily lead one to overlook other elements in a lipomatous growth.

#### SUMMARY

A case of lipoma containing neurofibromatous tissue is presented. Though the two growths were closely associated in this case, there is no definite proof as to the neurogenic origin of the lipoma. The presence of nerve fibers in lipomas and the occasional association of neurofibromatosis with multiple lipomas are discussed. The importance of a careful examination of all lipomas is stressed.

We are indebted to Dr. A. P. Stout, Department of Surgical Pathology, College of Physicians and Surgeons, New York, and to Dr. William Boyd, University of Toronto, Canada, for examining the specimen and for permitting us to quote their opinion.

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# CONGENITAL TERATOMA OF THE THYROID

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GRAND JUNCTION, COLORADO

**T**UMORS of the newborn have aroused the interest of the practitioner, obstetrician, and pathologist since the early days of medicine. The uncommonness of their occurrence and development explains this interest sufficiently.

The type of tumor reported in this paper—teratoma—occurs most frequently in the ovary and in the testicle and next most frequently at the two ends of the original infolding of epithelium in the primitive embryo, namely, in the sacrococcygeal region and in the bronchogenic region. Teratomas of the thyroid gland, however, are very rare. Russell and Kennedy,<sup>1</sup> in a report of a case published in 1913, state that in twenty-two annual volumes of this journal only one reference has been made to it (Hewetson<sup>2</sup> 1903). Pusch and Nelson<sup>3</sup> in a clinical revision up to 1935 could collect only twenty-eight authentic cases from the entire world's literature, the first case dating back as far as 1691. Another case was published since this comprehensive article by Potter<sup>4</sup> in 1938. Most of the cases reported have been stillborn or in a prematurely delivered fetus. Almost without exception those born alive have not survived more than a few days. Tammann, of the Clinic of Goettingen, in 1925 reported a case with a tumor 4 cm. in diameter, successfully operated upon.

There has never been a satisfactory explanation as to the origin of these tumors. The most understandable theories are perhaps: (1) Separation of a totipotent blastomere in the early stage of cell cleavage and its migration to a point where it later develops, and (2) some kind of twinning with overgrowth of one twin.

As to the occurrence in the thyroid, it would seem possible that a fertilized polar

body could have been included in the primitive infolding of the epithelium in the branchogenic region which later forms the thyroid primordium and migrates down from the second branchial arch through the hyoid, past the larynx to the upper portion of the trachea. In the many complex changes in this region, the thyroid anlage meets with many bizarre accidents and aberrant thyroid glands result in the nasopharynx in, on or beneath the tongue, in the wall of a thyroglossal cyst, pre-laryngeal, intratracheal, intra-esophageal, supra- or subclavicular,—or in the posterior triangle of the neck. The occurrence of such a variety of accidents to the thyroid in the embryo lends argument to the theory of inclusion of a polar body or of some other multipotent cells from the primitive germ layers within tissues undergoing invagination or fusion.

Because of the rarity of these cases and our limited experience with them, it is desirable that new cases be reported whenever found. Every new report is apt to furnish more details heretofore unknown, and will contribute to our knowledge of the pathogenesis of these formations.

## CASE REPORT

K. L. was four weeks of age when his mother brought him for the first examination. She reported that it was a normal birth and K. was the third child. The others are healthy and normal. Neither parent was goitrous. The father's sister and mother's mother had goiters. When K. was born, the parents noticed a slight swelling of the left side of his neck and some breathing difficulties in certain positions. They thought it would disappear, but it did not. On the contrary, it seemed to increase in these four weeks. The breathing was worse in feeding and sleeping on the right side. Sometimes the



baby really turned blue and became limp and unconscious.

The first examination showed a slightly

as a whole, was slightly dislocated to the right side. There was a definite inspiratory stridor noticeable mainly when the baby's head was

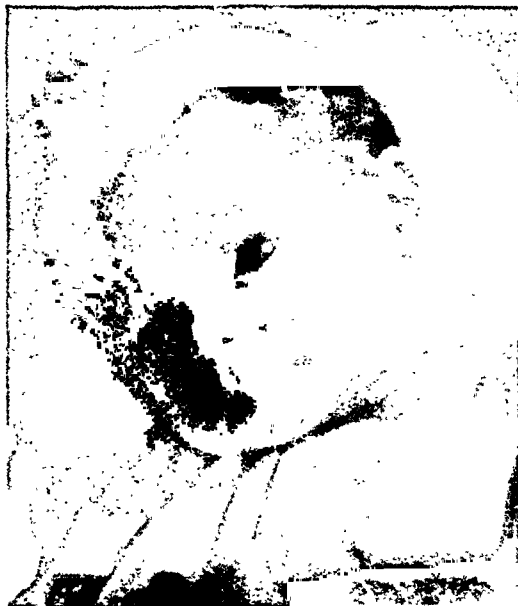


FIG. 1. Baby at first examination. Tumor of left thyroid lobe.

cyanotic, somewhat undernourished child with a left sided tumor of the neck. (Fig. 1.) It was the size of a fist, was covered by normal skin, and belonged apparently to the left lobe of the thyroid gland with which it moved upward in



FIG. 2. Baby four months after operation. Tumor completely gone, child excellently developed and free of any tumor symptoms.

turned to the right side; in this position the baby was slightly cyanotic. Otherwise, the baby appeared normally developed. The x-ray ex-



FIG. 3. Tumor removed at operation; nodular surface.



FIG. 4. Cross section of tumor. Left side hard, containing bony parts; right side spongy; numerous cavities; fibrous capsule surrounding entire tumor.

swallowing movements. The tumor itself was not movable nor separable from the thyroid gland. No tenderness or inflammation was present.

Nose and pharynx were normal. The laryngoscopy showed a normal larynx which, perhaps

amination showed a slight displacement of the trachea to the right side with little narrowing of its lumen in the uppermost portion. The tumor was non-opaque, but within its limits several small densities were discernible.

The clinical and x-ray examination led to the diagnosis: Unusual nodular goiter, perhaps fetal adenoma.

the trachea. Keeping up this pull, the operation could be finished uneventfully without resorting to tracheoscopy or tracheotomy. The

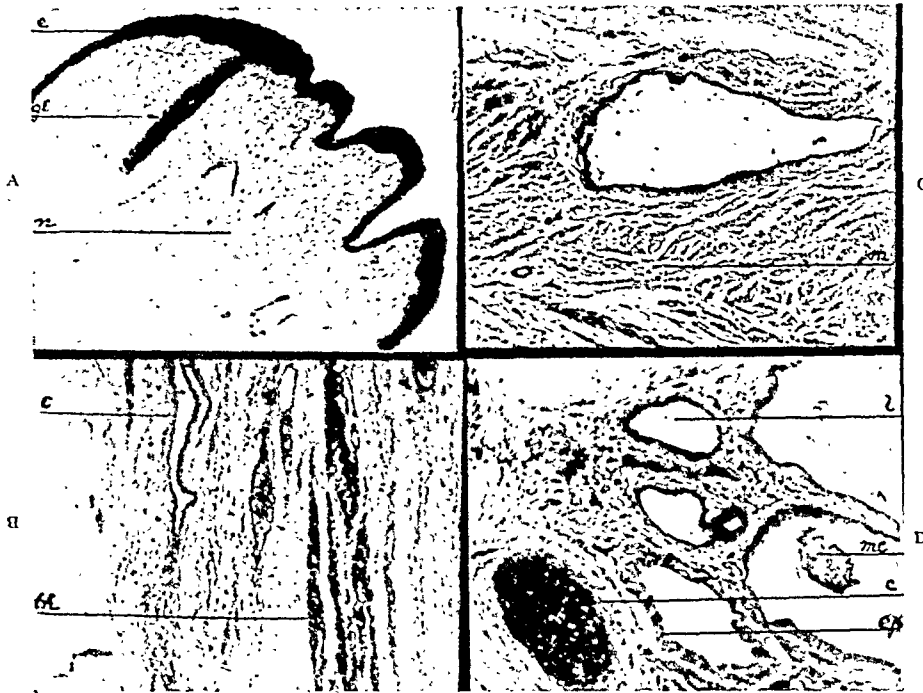


FIG. 5. Microscopical sections through tumor; complete absence of thyroid tissue except in B. A, embryonic nerve tissue (*n*) covered by squamous epithelium (*e*); gland tubule (*gl*) lined with squamous epithelium. B, part near capsule; *c*, capsular vein. There are several rows of atrophic thyroid acini, the only place in the tumor where thyroid tissue could be found. C, striated muscle (*m*) around a cavity. D, lumina (*l*) lined with columnar epithelium (*ep*) and containing mucus (*mc*); hyaline cartilage near by (*c*). The whole formation is suggestive of an abortive attempt at bronchus and lung formation.

Operation was recommended on account of the breathing difficulties. The parents wanted to take the baby home first, but were advised to watch the baby's breathing and to report instantly in case it became worse. They came back two weeks later when they discovered the baby's condition slightly worse. The stridor was continually noticeable and the swelling had somewhat increased in size.

Operation was performed on August 5, 1942. Everything was ready for an instant tracheoscopy and introduction of a narrow tube through the larynx into the trachea at a moment's notice and for a tracheotomy as well should signs of suffocation appear during the operation. After administering the first few drops of ether, the breathing seemed to become worse and still looked critical during the incision of the skin, but it improved considerably, against expectation, when the tumor was grasped with the forceps and pulled away from

operation consisted in removing the entire tumor from the left lobe of the thyroid gland, to which it definitely belonged and by which it was surrounded in its whole circumference. After splitting a thin layer of thyroid tissue, what appeared the capsule of the tumor was struck and the tumor could be removed in its entirety with its capsule in blunt dissection. It seemed attached to the surrounding tissue only near the trachea. Bleeding was inconsiderable. The breathing became instantly normal after separating the tumor from the trachea and remained so through the postoperative course of healing, which occurred uneventfully and per primam. (Fig. 2.)

The removed tumor (Fig. 3) measured about  $2\frac{1}{2}$  by  $1\frac{1}{2}$  inches and showed a smooth but nodular surface in some of its portions. The specimen was fixed in formalin for a few days and then cut in two. It showed a very unusual picture on its cross section. (Fig. 4.)

Within a thin fibrous capsule numerous cavities could be seen and between them tissue of different consistency and structure. The knife

mucus, suggested embryonic bronchial formation (Fig. 5D); occurrence of foci of cartilage confirmed this suggestion and the whole section

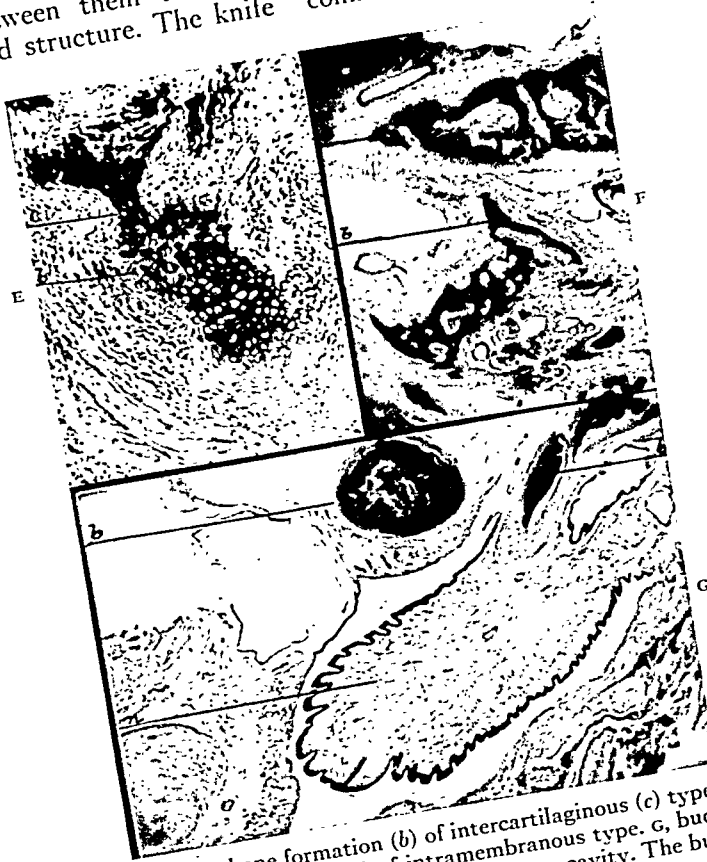


FIG. 6. E, bone formation (b) of intercartilaginous (c) type. F, bone formation (b) of intramembranous type. G, bud-like projection (n) of nerve tissue into a cavity. The bud is covered by squamous epithelium and contains bone in its root and near by (b).

felt some hard resistance like ossifications which belonged to the left part of the tumor in Figure 4; this part was made up of a tough fibrous tissue basis and could be differentiated microscopically from a right lobular part which showed more spongy appearance and seemed gelatinous in its consistency.

The microscopic examination was made from several portions of the tumor and showed complete absence of the thyroid tissue except in a small area of the capsule where several rows of atrophic thyroid acini were present. (Fig. 5B.) No colloid material was seen in any part of the various sections.

The greater bulk of the tumor was made up of mostly heterogenous tissue elements with embryonic nerve tissue (Figs. 5A and 6G) which seemed almost the matrix of the whole tumor. A net of lumina lined with columnar epithelium and containing

may well represent an abortive attempt at formation of a lung. Gland tubules lined with squamous epithelium showed the character of the epidermis of the embryo. (Fig. 5A.) An island of hyaline cartilage could be seen, bone formation of intercartilaginous type (Fig. 6E) and of intramembranous type (Fig. 6F and G), striated muscle. (Fig. 5C.) Pigmented columnar epithelium and isles of dark staining melanin represented very likely embryonic retina. There were many bud or polyp-like projections of connective and nerve tissue into the cavity spaces. (Fig. 6G.) Nowhere did the various elements form a definite structure nor arrange themselves to form an organ.

#### COMMENT AND SUMMARY

We are concerned here with a growth of the thyroid gland made up of elements

entirely different from the normal constituents of thyroid tissue.

The various elements of the tumor showed the following origin: (1) Ectodermal: nerve tissue, squamous epithelium, pigmented epithelium, hair follicles, sweat glands; (2) mesodermal: cartilage, bone, muscle, connective tissue, and (3) entodermal: columnar epithelium of tracheo-bronchial character.

This survey shows that all three germinal layers were represented in the tumor and the tumor, therefore, must be regarded as a real congenital teratoma or embryoma. Clinically it caused symptoms of suffoca-

tion soon after birth which could be eliminated by surgical removal of the tumor.

The rarity of the case justifies this report. The fact that this observed case is one of the very few which has been found and diagnosed in the living, and has been operated upon and cured, makes it still more worth while recording.

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INTRAMEDULLARY tumours are usually malignant, and are commonly gliomatous. Other varieties include tuberculoma, cyst, and endothelioma, which have probably originated from invagination of the pia mater which lies in the posterior spinal sulcus, or else have become embedded in the cord.

# HYPOGLYCEMIA AND ABDOMINAL PAIN

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MEDICAL CORPS, ARMY OF THE UNITED STATES

**S**PONTANEOUS hypoglycemia is important surgically since it may produce abdominal pain that must be differentiated from surgical lesions. In definition, Allan considers hyperinsulinism is manifested by hypoglycemia and the symptoms which accompany the fall of sugar content to a lower level. However, hypoglycemia can occur from other causes and does not by any means invariably indicate hyperinsulinism.

Harris, in 1924, two years after discovery of insulin by Banting, first called attention to hyperinsulinism. Since this time much literature has accumulated on the subject. The surgical literature contains many articles with reference to islet cell tumors as a cause of hypoglycemia. The combined experiences of the surgeon and the internist have shown that not all cases of hypoglycemia are due to pancreatic tumors or malignancy. Conn has published a comprehensive etiologic classification of the spontaneous hypoglycemias. Of the two main groups of cases, organic and functional, it is believed that we are most concerned with the functional type in this paper.

West and Kahn have stated that hypoglycemia and consequent overfunction of islands of Langerhans, without tumor formation, is occasionally seen in the newborn, especially in those of diabetic mothers, and occasionally in early childhood, but has been reported infrequently as a definite finding in adults. These authors considered that opposing endocrine secretions, disturbed liver glycogen function, central nervous system lesions, and faulty dietary habits contribute to functional spontaneous hypoglycemias. Harris wrote that patients with diabetes have given histories of hypoglycemic symptoms. He suggested that there may exist

a family tendency as in diabetes. Allan stated that although hyperinsulinism related to known organic disease is rare, it is thought by some that many of the cases of hypoglycemia represent functional hyperinsulinism. Whether this is true or not, conditions which require consideration of hyperinsulinism are seen not uncommonly. The author agrees with this idea, since in being alert to the possibility of hypoglycemia as a cause of abdominal pain it had to be considered in the differential diagnosis of pain of intra-abdominal lesions. In a period of approximately one year, ten patients were found to have abdominal pain due to hypoglycemia which was controlled by dietary means.

The symptoms of hypoglycemia are variable, depending upon the degree of decrease of blood sugar. The great bulk of symptoms occurring in hypoglycemia may be considered neurologic in origin. Abdominal pain as a result of hypoglycemia has been previously reported. Harris stated that pain of hyperinsulinism has simulated appendicitis, gallbladder disease and duodenal ulcer. The pain is usually exaggerated during attacks, though it may be present more or less constantly. Also tenderness may be elicited over the pancreas on deep palpation. This pancreatic tenderness is most easily elicited by deep palpation of the epigastrium above the umbilicus and just to the left of the midline. Harris considered that pain and tenderness are most frequent when a pancreatic tumor exists. Sandler wrote that pain in hypoglycemic patients may be generalized or localized. The localization of pain may be in any portion of the abdomen. He stated that hypoglycemia has a tendency to stimulate the same group of neurons in the vagal nucleus and the particular segment of the gastrointes-

tinal tract (including the biliary tract) innervated by these neurons undergo strong contraction, which may even be tetanic. Allan stated that variability and diversity of the symptoms make the clinical picture appear complex, but recognition of the disorder is simplified by a common characteristic, particularly, that the symptoms tend to occur when the stomach is empty and subside after eating or drinking sugar-containing foods. The pain of hypoglycemia may simulate the anginal pains of heart disease.

There may be a confusion of abdominal pain of hypoglycemia where associated lesions such as acute hepatitis, malignant lesions of the gastrointestinal tract, starvation states, cachexia, and liver glycogen dysfunction exist. Brown and Harvey have reported hypoglycemia in "smoke" drinkers. These patients may have abdominal pain. Collier and others deduced that when a glycosuric patient is found to have a low fasting blood sugar level the disturbance in carbohydrate metabolism is most likely to be on the basis of hepatic disease. He stated that the glucose tolerance test with normal or low fasting blood sugar levels rising during the first and second hour to higher levels than normal, and finally falling to hypoglycemic levels during the third, fourth, and fifth hours, is probably indicative of dysfunction of the liver. Reports have appeared in the literature stressing the fact that hypoglycemic attacks occur in some women in the first days of menstruation. Therefore, confusion of menstrual cramps with hypoglycemic pain may occur. Hypoglycemic states may accompany or result from renal glycosuria.

In the treatment of hypoglycemia, since most cases are not associated with organic pancreatic disease and do not fulfill the indications for surgery as outlined by Whipple, other methods must be sought. Conn has discussed the use of a high protein, high fat, and low carbohydrate diet. Since it has been biochemically shown that about 58 per cent of protein is oxi-

dized as carbohydrate, a slow absorption of glucose results. If large amounts of carbohydrate, readily absorbed, is ingested, insulin secretion is stimulated in excess of the amount required to utilize the sugar intake. The excess glucose required to neutralize the insulin must be drawn from blood sugar and liver and muscle glycogen. This cycle of events results in a vicious circle so that glycogen stores never reach capacity for compensating blood losses. It is obvious from this reasoning that carbohydrate diet is not successful in treatment of hypoglycemia.

In making clinical interpretations of hypoglycemia, the blood sugar levels, as set forth by Harris, were used: (1) mild cases 75 to 65 mg. of blood sugar, (2) moderate cases 65 to 55 mg., and (3) severe cases 55 mg. and below.

The following case reports are of patients found in approximately one year of search. Five patients had an appendectomy performed. Three of these were operated upon after the clinical impression of hypoglycemia was established, while two were operated upon before. One of these two was operated upon by another surgeon. This patient had an incomplete inguinal hernia at the time he appeared for examination and study. The hernia was not repaired for the pain was relieved by dietary means. The appendices showed low grade infection.

#### CASE REPORTS

CASE 1. Mrs. E. T., age thirty-four years, had had severe attacks of nausea, vomiting, and epigastric and right lower quadrant pain. She had noted exacerbation of symptoms six to eight hours after overeating of carbohydrate foods. After attending a party on one occasion at about the age of twenty-five years, she was operated upon for "appendicitis." Her postoperative convalescence was stormy with severe nausea and vomiting. These attacks promptly recurred and another medical opinion was given that attacks were due to her menses. About ten years ago she had a convulsion and unconsciousness following overeating of sweet foods. A medical opinion of brain tumor was given at this time,

and that nothing could be done. Following a pregnancy six years ago she required six months for convalescence. During the last two to three years her symptoms have become worse. Additional symptoms such as tremors (dropping dishes), headaches, dizziness, weakness, extreme tiredness, craving for candy, hunger, and flushing have developed. The attack which led to the diagnosis followed about six to eight hours after a large Thanksgiving dinner. The patient had a severe nausea and vomiting with epigastric pain which was not controlled by ordinary medication. She was hospitalized and given 1000 cc. of 10 per cent glucose in saline intravenously. In two hours all symptoms had disappeared and the patient wanted to go home.

Physical examination gave no positive findings except a slight, non-localized, epigastric tenderness. Temperature was 98.4°F. Laboratory findings showed a blood sugar of 88 mg. per 100 cc. of blood (after the glucose had been given). A fasting blood sugar was then found to be 65 mg. per 100 cc. of blood and the urine showed 1.25 per cent sugar. A glucose tolerance test (six hours) with urinary sugar test was done to give the following results:

Specimen	Blood Sugar per 100 Cc.	Urinary Sugar
1—30 minutes	100 mg.	1.65 per cent
2—2 hours	109 mg.	3.50 per cent
3—3 hours	77 mg.	1.16 per cent
4—4 hours	83 mg.	.77 per cent
5—5 hours	50 mg.	.30 per cent
6—6 hours	61 mg.	.10 per cent

In view of the persistent glycosuria together with the low blood sugars, the patient was considered to have renal glycosuria which contributed to the loss of blood sugar. This patient had an irresistible craving for candy and was unable to pass a candy counter when shopping without buying and eating large amounts of candy. She was placed on a diet of protein 120 Gm., fat 150 Gm., and carbohydrate 120 divided into four meals daily. In about four weeks she was symptom free and the glycosuria which was constant became intermittent. Against the wishes of female patients, she gained thirty-five pounds. However, she considered the weight gain more tolerable than the symptoms which she had had for years.

CASE II. E. A., a white male, twenty-eight years of age, was an asthenic type of person who had complained of gastrointestinal symp-

toms for six months. He had epigastric pain, cramp-like in character, associated with bloating, belching, vomiting, and spells of diarrhea. He had been seen elsewhere on several occasions and had been given gastrointestinal x-ray studies. Although he was told that no ulcer could be demonstrated, he was given ulcer therapy without relief. Two months before appearing for this study his pain had become constant with radiation of pain to the right lower quadrant accompanied by severe diarrhea and vomiting.

Physical examination was negative except for tenderness in the epigastrium and right lower quadrant. He was considered clinically to have a chronic recurrent appendicitis. Appendectomy was done and the patient was symptom-free for three months. Laboratory study of blood sugars showed a fasting sugar of 88 mg. per 100 cc. of blood. Glucose tolerance test (six hours) showed first hour 62.5 mg., second hour 75.0 mg., third hour 80.0 mg., fourth hour 111.0 mg., fifth hour 66.0 mg., sixth hour 63.0 mg. per 100 cc. of blood. The symptoms were reproduced during the glucose tolerance test.

The patient was considered to be hypoglycemic and was placed on a diet of protein 120 Gm., fat 140 gm., and carbohydrate 120 gm. The diet was divided into four meals daily. The patient maintained his diet and gained weight for about six weeks. He then began to indulge heavily in alcoholic beverages and symptoms promptly recurred. He developed dizziness, weakness, sweating, fatigability, precordial pains, fainting, and tremors.

CASE III. P. W., a white male, asthenic type, thirty-two years of age, complained of dizziness, weakness, fatigability, and epigastric pain. There were attacks of nausea and vomiting. His epigastric pain was most intense when his dizziness was most severe. He had been examined and treated by twenty doctors in the past two or three years with no relief of symptoms. Perspiration was profuse at times. The patient had lost ten pounds in the past two years.

Physical examination showed only slight tenderness over the pancreatic area. There were no palpable masses or enlargement of solid organs. The fasting blood sugar was 71 mg. per 100 cc. of blood. Glucose tolerance showed first hour 132 mg., second hour 58 mg., third hour 54 mg., fourth hour 56 mg., fifth

hour 61 mg., and sixth hour 63 mg. per 100 cc. of blood.

The clinical impression was spontaneous hypoglycemia as the cause of the abdominal pain. The entire symptom complex of which the patient complained was reproduced during the glucose tolerance test. The patient was placed on a high protein and fat and low carbohydrate diet. He failed to return so that it is impossible to express the results in this case.

CASE IV. F. J. H., a white male, well developed and nourished, age thirty-four years, complained of chronic constipation, anorexia, and recurrent pain in the right lower quadrant. About one year previously he had had an appendectomy for a chronic appendicitis. He felt fine for about six months and then began to have a feeling of bloating, dizziness, nervousness, inability to concentrate at work, and headaches.

Physical examination showed only a small, easily reducible, indirect, inguinal hernia and an appendectomy scar. The hernia was not tender to palpation. Laboratory studies of blood and urine were normal. However, the fasting blood sugar was 70 mg. per 100 cc. of blood. Glucose tolerance (six hours) gave the following results: first hour 159 mg., second hour 158 mg., third hour 88 mg., fourth hour 43 mg., fifth hour 46 mg., and sixth hour 60 mg. per 100 cc. of blood.

Clinically, this patient was considered to have spontaneous hypoglycemia. He was advised of the findings and placed on a diet high in protein and fat but low in rapidly absorbable carbohydrates. He was told that if pain was not relieved by this procedure a repair of the hernia would be indicated. After three weeks of dietary care all symptoms were gone.

CASE V. G. O. T., a white male, asthenic type, age thirty years, related the story that he had a "strep" throat and had been given sulfanilamide. Two months after this he began to have epigastric burning pain. The pain was severe when he was hungry. The pain was also worse in midmorning and afternoon. His bowels were constipated and bloating and flatulence were severe. The pain also projected to the right lower quadrant and was accompanied by nausea. The patient admitted drinking whiskey in large amounts for relief of the pain. He had been to other doctors and was given therapy for "ulcers" without relief.

The physical examination showed moderate epigastric tenderness and severe right lower

abdominal tenderness. There were no abdominal rigidity or masses. Rectal (digital) examination produced acute right pelvic tenderness. The white blood count was 8,350. Blood amylase was 83; fasting blood sugar was reported as 75 mg. per 100 cc. of blood.

On the basis of physical findings, an appendectomy was done. The appendix was of the chronic obstructive type.

During the postoperative convalescence a glucose tolerance test (four hours) was done with the following results: first hour 157 mg., second hour 132 mg., third hour 93 mg., and fourth hour 50 mg. per 100 cc. of blood.

The appendectomy relieved the patient of lower abdominal pain and tenderness. The epigastric findings were improved and relieved in about three weeks when the patient was placed on a high fat and protein and low carbohydrate diet.

CASE VI. M. M., a white, single, female, asthenic type, age twenty-three years, complained of recurrent pain in the right lower quadrant, belching, bloating, and indigestion. She suffered a loss of appetite and had lost ten pounds in about one month. The recurrent abdominal symptoms had been present for about four years. Weakness, headaches, and palpitation occurred.

Physical examination showed acute tenderness in the right lower quadrant and a *Trichomonas vaginalis*. The vaginitis was successfully treated but the abdominal pain continued to recur. Her weight had dropped to eighty-seven pounds. Laboratory studies showed white blood count 9,850 with other counts negative. Cystoscopy and x-rays showed a normal urinary tract; basal metabolism rate -7, fasting blood sugar 80 mg. per 100 cc. of blood.

The glucose tolerance test (six hours) gave first hour 128 mg., second hour 75 mg., third hour 61 mg., fourth hour 66 mg., fifth hour 68 mg., sixth hour 71 mg. per 100 cc. of blood.

An appendectomy was performed through a right transrectus incision. No other pathological findings were present on exploration. The appendix was of a chronic obstructive type. The patient was placed on a high protein diet and all previously existing symptoms cleared. When the patient relaxed her dietary vigilance, symptoms soon recurred.

CASE VII. M. B., a white male, twenty-one years of age, well developed and nourished with some obesity, had complained of epigastric soreness and pain in the right lower quadrant



associated with nausea for two or three months. He claimed that he was hungry most of the time. There had been spells of dizziness, precordial pain, and no relief of symptoms by food intake. He indulged heavily in alcoholic beverages during week ends.

Examination showed moderate tenderness over the entire epigastrium with moderate tenderness in the right lower quadrant. Blood pressure was 140 systolic and 88 diastolic with a pulse rate of 80 per minute. Graham-Cole study revealed a normal functional gallbladder. White blood count was 10,800, with the remaining blood picture being normal. The fasting blood sugar was 81 mg. per 100 cc. while the glucose tolerance test gave the following readings: first hour 93 mg., second hour 100 mg., third hour 75 mg., fourth hour 73 mg. per 100 cc. of blood.

An appendectomy was done and the pathological study demonstrated a subacute appendicitis. This operative procedure with diet of extra protein and fat controlled all symptoms. The patient's alcoholic habits and neglect of diet brought a return of gastrointestinal symptoms. Dietary vigilance always produced relief of his symptoms. This patient enlisted in the Army Air Corps and has been unable to qualify as a pilot.

**CASE VIII.** A. S., a white male, age thirty-five, somewhat obese, was a heavy drinker at times but he denied any indulgence in the present attack. He stated he had passed out at work, and two days later again on the street at night to produce bruises about his face. He was found by the police and was placed in jail over night in the belief the patient was drunk. He complained of having recurrent epigastric pain, nausea at times, dizziness, and loss of appetite.

Examination showed him to be obese and weighing 198 pounds. There was slight epigastric tenderness. He had recovered from a hernia operation three months before and presented a well healed scar. Blood pressure was 150 systolic and 70 diastolic, while the pulse rate was 88, regular and normal in volume. The blood and urine findings were within normal limits. Fasting blood sugar was 77 mg. per 100 cc. of blood. A glucose tolerance test showed: first hour 150 mg., second hour 125 mg., third hour 75 mg., fourth hour 69 mg., and fifth hour 65 mg. per 100 cc. of blood.

A restriction of alcoholic consumption and diet of extra protein and fat controlled all the

symptoms. After relief of his symptoms he followed his diet poorly, but he could always produce a reversal by resuming his controlled diet.

**CASE IX.** A white female, age twenty-eight, well developed and nourished, tending to be obese, complained of attacks of marked dizziness, headaches, tremor, and generalized abdominal pain associated with indigestion. She had been told two years before that she had low blood sugar and that her basal metabolism was within normal limits.

Physical examination demonstrated no positive findings to explain the symptoms. There was no local abdominal tenderness. A fasting blood sugar was 81 mg. per 100 cc. of blood. The glucose tolerance test showed: first hour 100 mg., second hour 112 mg., third hour 50 mg., fourth hour 40 mg., fifth hour 47 mg., sixth hour 51 mg. per 100 cc. of blood. The glucose tolerance test produced symptoms of dizziness, tremors, drowsiness, and abdominal pain about three hours after administration of the glucose.

This patient was placed on a diet high in proteins and fats, and carbohydrates were reduced to a minimum. On this regime she was able to control all symptoms.

**CASE X.** E. S., a white male, age forty-two, asthenic and nervous type, had had precordial pain recurring and three years previously had an attack with syncope. He was attended by a doctor in another city who had performed several electrocardiographic readings which were not considered indicative of heart disease according to the patient. At the time he appeared for examination he complained of drowsiness, weakness, lack of ambition, and general abdominal pain. He was unable to keep up with his duties as manager of a large chain store business. He had given up this responsibility in the belief that he was suffering from heart disease.

Physical examination gave no evidence of disease. The heart size was normal to percussion and on auscultation there were no murmurs. Blood pressure was 110 systolic and 68 diastolic. His pulse volume was normal, while the rate was 72 with a regular rhythm.

Laboratory findings were: urine negative, red blood count 4,700,000, white blood count 7,700, hemoglobin 13.2 Gm. (86 per cent). Blood chemistry results were: fasting blood cholesterol 228 mg. per 100 cc. of blood; fasting blood sugar 88 mg. per 100 cc. of blood;

glucose tolerance test first hour 150 mg., second hour 84 mg., third hour 63 mg., fourth hour 70 mg., and fifth hour 77 mg. per 100 cc. of blood. Electrocardiogram showed no evidence of heart disease. Basal metabolism was -4.

Gastric analysis (fractional) showed no free hydrochloric acid and a combined acids of 8. There was no change after alcohol but with histamine stimulation free hydrochloric acid reached 65 and the combined acids of 15.

All symptoms were controlled by high protein and fat diet. He was also given thyroid extract (1 gr.) daily. The patient has returned to his managerial position.

#### COMMENTS

These ten cases definitely demonstrate that abdominal pain in hypoglycemias occurs when surgical intervention is not indicated. These reports show that patients with recurring abdominal pain require differential diagnostic procedures to rule out appendicitis, gastric or duodenal ulcers, cholecystitis, hepatitis, chronic pancreatitis, and other abdominal lesions. Patients in the age group of twenty to forty years, in whom operative procedures have been done with no relief or recurrence of symptoms, should be studied for hypoglycemia. The author believes that the syndrome of hypoglycemia is far more common than is usually suspected since

it has been possible to find ten patients in the short time of approximately one year of search.

#### CONCLUSIONS

1. Patients having recurrent abdominal pain in the absence of positive acute lesions of the abdomen should be studied for hypoglycemia as a cause of the pain.

2. Spontaneous hypoglycemias not due to pancreatic tumors can be controlled by a diet high in protein and fat but low in carbohydrates.

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# A SIX MONTHS' TUBAL PREGNANCY\*

## CASE REPORT

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**T**UBAL gestations developing for twenty-four weeks or beyond are still of sufficient interest and rarity to permit reporting. Although cases simulating this one are found in the literature, there are interesting features which might well be recorded.

### CASE REPORT

The patient, a thirty-one year old colored woman, was first seen at the Greenpoint Hospital out-patient prenatal clinic on November 17, 1942, at which time she was six months pregnant. She presented herself because she had not felt fetal life for the past two weeks.

There had been one previous pregnancy which terminated in a spontaneous delivery of a normal 10 pound infant eleven years previously. Menstruation had begun at the age of thirteen, the interval was twenty-eight days, and duration five days with no dysmenorrhea. At the age of fifteen and again at twenty-two years, the patient had had "tube trouble." This was the only significant fact in her previous history.

On examination the findings were as follows: Weight 169½ pounds, blood pressure 130/-8; abdominal mass the size of a 7 months' gestation, no fetal heart heard, no fetal movements made out.

Urinalysis was negative. The Wassermann and Kline reactions were also negative. X-ray examination was reported as follows: "The fundus of the uterus extends to the upper margin of the third lumbar vertebra. A fetus is present in the transverse position with the head on the right. The bones of the skull are not sufficiently well visualized for description but the fetus itself appears to be collapsed. This is suggestive of fetal death."

The patient was followed in the prenatal clinic at weekly intervals, the only complaints

being abdominal tenderness and a certain amount of mental depression as a result of the realization that the fetus was dead. The blood pressure became slightly elevated, reaching 158/98 but it soon fell and maintained a level of about 140/84. Urine remained normal and weight remained at 168 to 170 pounds.

On December 8, 1942, the patient reported that she had had slight vaginal spotting but no pain. She was admitted to the hospital. The findings were essentially as recorded before. On December 10, 1942, a vaginal examination was done. The cervix was uneffaced and not dilated. There was no evidence of rupture of the membranes. No presenting part was felt through the cervix. No bleeding occurred during or following this examination. In view of the fact that the fetus was dead and the uterus was not increasing in size, induction of labor was attempted with estrogenic substance followed by pituitrin.<sup>1</sup> This was repeated several times. On December 25th, the first febrile reaction was noted. A hyperpyrexia developed which persisted for twenty-eight days, the highest point reached being 102°. The origin of this fever was attributed to the vaginal examination which was thought to have stirred up a latent infection. Laboratory findings during this time were, white blood cells 19,800, sedimentation time 18 mm. in 10 minutes, urine clear, blood pressure 142/90.

X-ray examination taken on December 31st showed the same findings as on the previous examination.

In view of the febrile course which had ensued following vaginal examination, it was deemed inadvisable to institute any surgical procedure. Since medical induction of labor had failed, it was decided that the patient was to be allowed to proceed with no treatment until she delivered spontaneously.

During the next fifty-three days, during which the patient was followed in the out-

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patient department at two-week intervals, she felt well and was afebrile. She lost thirteen pounds in weight and the abdominal mass receded until it was the size of a five months' gestation. On March 30th, x-ray examination showed essentially the same findings as on the other examinations except for the fact that the uterus appeared smaller.

On May 6, 1943, the patient was readmitted. The abdominal mass was at the level of the umbilicus. Bimanual examination revealed the true state of affairs for the first time. The uterus could be made out to the right side of the pelvis and anteverted. It was a little larger than normal in size. On the left, one could feel the abdominal mass which was definitely not connected with the uterus. The diagnosis of extrauterine pregnancy was made and laparotomy performed under gas-oxygen ether anesthesia.

At operation, the uterus appeared normal in size, shape and position. The right tube and ovary were adherent to the posterior wall of the uterus and the right tube had been converted into a small hydrosalpinx. Above the uterus and almost in the midline of the abdomen was a firm mass measuring 10 by 15 by 20 cm. This mass was found to arise from the left tube. No left ovary could be identified. The omentum was adherent to the mass but these adhesions were fine and easily broken down. The mass was removed by clamping and cutting the left broad ligament which was then sutured. The right adnexa were not disturbed.

The patient made an uneventful recovery and was discharged on the eleventh day.

The pathological examination was made by Dr. Rosa Aronoff whose report follows: Gross: The specimen consists of an oval mass measuring 14 by 10 cm. in diameter. The external surface is mottled yellowish-grey and red-blue, is partly smooth, glistening and partly opaque, contains some slender as well as broad membranous tags. In one place incorporated in this mass is a short segment of a tubular structure about  $2\frac{1}{2}$  cm. in length and 0.5 cm. in diameter. The cut surfaces contain a large cavity occupied by a fetus of about six months' gestation. The wall of the cavity ranges from 0.1 to 3.0 cm. in thickness, is composed in the wide portion of soft opaque mottled gray-yellow and red tissue surrounded by a narrow band of closely set, firm strands. The soft outer zone

widens for a distance of 4 cm., to a thickness of 1 cm. and contains an occasional small cyst 0.3 cm. in diameter filled with clear watery

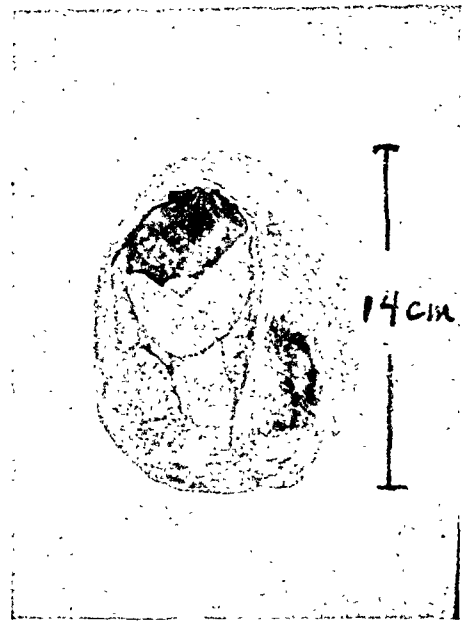


FIG. 1. Tube with window cut away to reveal fetus and placenta.

fluid. Five sections are taken for microscopic study.

Microscopically, in sections from the sac surrounding the fetus, the inner surface is irregular and made up of degenerated and in some places organizing chorionic villi merging with and extending into the underlying vascularized wall which is composed of parallel, longitudinal bundles of smooth muscle fibers. These are spread apart and infiltrated, especially about the vessels, by a moderate number of small round cells, large mononuclears, rare eosinophils and neutrophile polynuclears. Some areas are infiltrated with extravasated blood. Many of the imbedded vessels are thick-walled and have narrow lumina. In one place overlying the tube and partly fused with it is a zone of characteristic ovarian stroma containing an occasional follicular cyst and several corpora albicantia. A section from the short tubular segment presents the isthmus portion of the tube with intact coats and slight diffuse and focal infiltration by small round cells.

Diagnosis: Advanced tubal pregnancy of about six months' gestation.

#### COMMENTS

Several interesting features present themselves: First, the absence of abnormality in

the menstrual history for seven months of this gestation. In reviewing the histories of such cases presented in the literature this seems to be a common finding, more often true than not. There is no inkling of abnormality gleaned from the menstrual history to lead to the suspicion of an extrauterine gestation. Why this patient had painless spotting at seven months remains conjectural.

Second, the patient had two episodes of "tube trouble." Pelvic inflammatory disease has long been associated with the etiology of ectopic pregnancy. There seems to be a definite relationship found in this instance. One episode of pelvic inflammation developed at the age of fifteen years and the second developed at the age of twenty-two years, two years after termination of her first pregnancy. At the operating table gross evidence of previous pelvic inflammation involving the right tube and ovary was found.

Third, there is the patient's history of a relative sterility. The use of contraceptive devices was denied yet no second pregnancy developed for a period of eleven years. It is possible the first "tube trouble" involved the left side leaving the right tube and ovary free to function normally which it apparently did. Shortly after her first baby the right tube and ovary became involved in the second infection and there followed a period of relative sterility.

Fourth, there was a marked degree of hypertrophy and dilatation of an organ not ordinarily considered very distensible. Schumann's<sup>2</sup> suggestion in attempting to explain the extraordinary ability of the tube to dilate and hypertrophy seems plausible in this case. The placenta was located in the inferior margin of the ampullary portion of the tube, a site of rich blood supply and a site in contact with the elastic mesosalpinx, which would permit greater hypertrophy of the tube wall during placentation. Hence, there would be less danger of perforation by the eroding syncytial cells covering the elongated

anchoring villi. Since the ampullary region of the tube is the largest and most distensible portion, the fetus in turn would be permitted to continue its growth distally along a line of least resistance and not be hampered in its development by a too great lack of space.

Fifth, the presence of a flattened and incorporated left ovary and its suspensory ligament in the outer layer of the ovisac was another interesting feature.

Sixth, there was an apparently normal development of a six months' fetus. The mother first sought medical advice because of the cessation of fetal activity. The roentgenograms suggested a stillborn fetus developed to six and one-half to seven months. The succeeding roentgenograms recorded a gradual diminution in size of the infant. The fetus was not removed from the ovisac, hence accurate measurements could not be taken. The specimen was turned over to the Long Island College of Medicine.

Seventh, the patient's general well being was significant. Prior to her hospital admission her antenatal course was not suggestive of toxemia but following hospitalization and manipulation she did run a low grade septic fever which subsided and the remainder of her course was uneventful. The patient appeared mentally and physically well, at the time of surgery.

Eighth, the failure of multiple attempts at medical induction was striking. The patient suffered no apparent deleterious effects. The failure of these procedures which have been shown to be highly successful in inducing labor on women having intrauterine stillborn fetuses suggests extrauterine gestation.

We wish to express our appreciation to Dr. T. S. Welton, Director of the Obstetrical and Gynecological Service at Greenpoint Hospital, for granting permission to publish this case.

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# TWISTED OVARIAN CYSTS IN CHILDREN

## CASE REPORT

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**O**VARIAN cyst with torsion of the pedicle in children is an uncommon condition; only about one hundred twenty-five cases have been reported in the past one hundred years. Actually, about 97 per cent of ovarian cysts occur in adults instead of children.<sup>2</sup> The literature contains such interesting cases as an ovarian cyst in a seven months premature infant, and torsion of an ovarian cyst in a ten days old baby (Busch).

Abt<sup>1</sup> states that 60 per cent of various tumors of the ovary in children are malignant. Stevens<sup>9</sup> reports that the majority of ovarian cysts in children are dermoid and that they are four to five times as common as simple ovarian cysts with twisted pedicle. Ladd and Gross<sup>5</sup> claim that 60 per cent of ovarian tumors and cysts in children are malignant, but that 20 per cent are dermoid and 20 per cent are simple cysts, i.e., that dermoid and simple cysts occur with equal frequency in children. A simple cyst is filled with clear fluid while a dermoid contains hair, teeth, nails, sebaceous material and other ectodermal products.

The majority of twisted ovarian cysts in children occur on the right side for some obscure reason, and because of this right-sided preponderance the diagnosis is usually mistaken for an acute appendicitis, with or without abscess formation depending upon whether or not a mass can be palpated. Indeed, it is sometimes impossible to differentiate between an acute appendicitis with or without perforation and a twisted ovarian cyst in children as the history and physical findings are often very similar. Other conditions that enter into the differential diagnosis are intussusception, urolithiasis, mesenteric adenitis and

Meckel's diverticulitis. Rectal examination will often times be very helpful in arriving at the correct diagnosis, and the importance of doing a rectal examination, especially when the diagnosis is in doubt, cannot be too strongly emphasized. It is a procedure that we are too prone to neglect in children. This is clearly shown in the case about to be reported; both myself and my colleague failed to do a rectal examination. Had we done so, we may have arrived at the correct diagnosis as the cyst was located deep in the pelvis and would have been easily palpable. X-ray evidence is also of value sometimes especially in the case of dermoids after the urinary bladder is emptied, otherwise the cyst may be mistaken for a full bladder.

There may be symptoms of a vague character consisting of nausea and vomiting preceded by vague abdominal ache for a few days with one or more severe attacks of sudden abdominal pain lasting for a few hours, each severe attack seemingly coinciding with a tighter twist of the pedicle.

Surgical intervention for ovarian tumors and cysts in children should be undertaken as soon as the diagnosis is made, because of the high frequency of malignancy in children and also to forestall possible torsion of the pedicle.<sup>7</sup>

The following case which came under the observation of the author illustrates a typical case.

## CASE REPORT

D. S., age ten years, was first seen June 26, 1943, at 6:00 P.M. complaining of severe pain in the right loin, crampy in character, and of about two hours' duration. She had had a dull ache in the right lower quadrant for several

days, but on the day she was first seen it became much more intense. She had vomited once or twice following the acute onset of the pain.

before now confirmed that diagnosis. He also neglected to do a rectal examination.

An emergency operation was performed as soon as arrangements could be made. Under

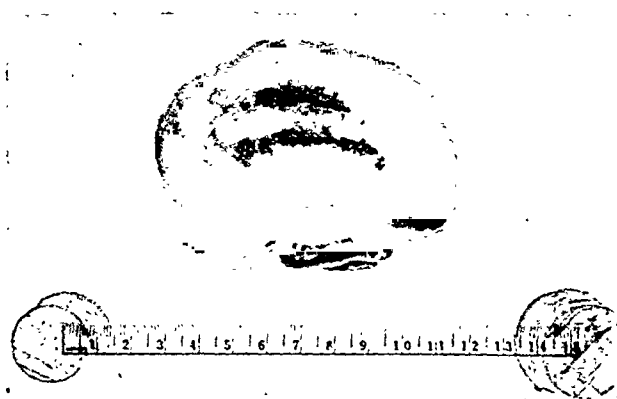


FIG. 1. Twisted ovarian cyst with distal half of right Fallopian tube.

Past illnesses and family history were irrelevant. The bowels were regular. There were no renal symptoms. She had no cough and her menses had not yet started.

Upon physical examination, her temperature was normal, pulse 100, respirations normal. The throat and chest were normal. The abdomen was soft; no masses were felt and there was absolutely no tenderness even on deep palpation. Rectal examination was not done. The urine was normal and the blood count showed red cells to be 3,648,000; white cells, 17,950; neutrophils 90, hemoglobin 72 per cent.

On consultation with another physician, his findings in the abdomen were essentially the same. He, too, failed to do a rectal examination. It was decided to keep her under observation for twelve hours withholding everything by mouth. In the morning, since she felt much better, she was allowed to leave the hospital and to take fluid by mouth.

The following morning I was called to see her again as the mother said that she was worse than ever. It seems that after leaving the hospital, she felt much better all that day and evening; she also had had a good night sleep. However, in the morning her pain returned more severe than ever. On physical examination, her fever was 99°F. by mouth, pulse 112, and the lower half of her abdomen was rigid and very tender. Rectal examination was not done. A diagnosis of acute appendicitis was made and the colleague who had seen her

ethyl chloride-ether anesthesia, a McBurney incision was made. The abdominal cavity was full of free bloody fluid. The appendix could not be immediately located. On exploration, a large cystic mass was palpated deep in the pelvis and was delivered into the wound with slight difficulty due to adhesions after first enlarging the incision. This mass turned out to be a right cystic ovary, the size and shape of a large kidney, with the pedicle twisted. After untwisting the pedicle, the distal half of the right tube was found to be gangrenous due to its involvement in the twist. The pedicle and distal half of the tube were clamped, cut, and the ends transfixed. The uterus and left tube and ovary were normal. The appendix was now easily found; it was normal and was removed. The abdomen was closed in layers without drainage.

Recovery was uneventful except for a bloody liquid stool on several occasions which was not investigated further and she was discharged on the twelfth postoperative day.

The pathologist's report was as follows: Gross specimen: a formalin fixed ovary and attached Fallopian tube which have a combined weight of 170 Gm. The ovary is bean-shaped and possesses the following measurements: length 9.8 cm., width 4.8 cm., and thickness 5.0 cm. Upon longitudinal cut section, it is found that there has been a marked hemorrhagic extravasation into the entire parenchyma. Discernible through out the cortex are occasional cysts which measure up

to 0.8 cm., and which are filled with clear fluid.

There has also been an extensive hemorrhagic extravasation of the Fallopian tube. A cross section of the pedicle reveals a thrombosis of the veins.

Histological examination: Sections reveal a marked hemorrhagic extravasation of the parenchyma. No tumor is present. The red blood corpuscles are well preserved, but densely grouped. A section across the pedicle shows the veins to be filled with recent thrombus. The diagnosis is strangulation, ovary and Fallopian tube; hemorrhage, ovary and Fallopian tube, marked.

#### SUMMARY

Ovarian cyst with torsion of the pedicle in children is a rare condition and is usually mistaken for acute appendicitis when it occurs on the right side.

The importance of rectal examinations in children is emphasized especially in obscure abdominal conditions.

Surgical treatment is simple and the results are very good.

An accompanying case report illustrates a typical case.

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# APPENDICITIS IN SITUS INVERSUS TOTALIS\*

## CASE REPORTS

COLONEL MANFRED U. PRESCOTT AND CAPTAIN RICHARD W. ZOLLINGER  
MEDICAL CORPS, ARMY OF THE UNITED STATES

FALIRICIUS,<sup>1</sup> in 1600, reported a case of reversed position of the liver and the spleen. This was the first case of transposition reported in the literature in man; however, Aristotle recorded observations in two instances of transposed organs in animals. Petrius Servius,<sup>2</sup> in 1615, recorded a case of transposition at autopsy and it was not until 1824 that Krichenmeister<sup>1</sup> accomplished the diagnosis in a living patient. Vehsemeyer<sup>3</sup> demonstrated the condition by means of x-ray. After this the incidence of the condition became established because of the ease with which the diagnosis could be made with laboratory aid.

The incidence of this anomaly has been quoted by many authors. Sherk,<sup>2</sup> in 1922, observed the condition ten times in 347,000 hospital admissions at the Mayo Clinic from 1910 to 1922. Willis,<sup>4</sup> in 1925, reported three cases in 10,000 hospital admissions. LeWold<sup>5</sup> recorded twenty-nine cases in 40,000 x-ray studies or one in approximately 1,400 cases. In 1926, in a review of the literature, Cleveland<sup>6</sup> was able to collect 400 cases. Twelve years later Larson<sup>7</sup> in a similar review estimated that approximately seventy-five cases had been added since the report of Cleveland in 1926. From an autopsy standpoint Rosler<sup>8</sup> found transposition in three cases in 22,402 autopsies. Adams and Churchill<sup>9</sup> state that situs inversus occurred in twenty-three of 232,112 patients admitted to the Massachusetts General Hospital.

In admissions to the Station Hospital, Truax Field, three cases of transposition were found. Two of these were diagnosed by physical examination and corroborated by x-ray. One of these was further proved

by operation. The third case was discovered on routine chest x-ray examination and gastrointestinal x-ray studies. There have been 7,072 chest x-rays accomplished at this station and the last case mentioned above is the only case accidentally discovered.

## CASE REPORTS

CASE 1. On October 28, 1942, the patient was admitted to the Station Hospital. He was forty-three years of age and his complaints were sore throat, cough, and chills of two days' duration. The rest of the history was not pertinent. The essential physical findings were redness of tonsils and nasopharynx. Examination of the heart revealed the apex beat to be within the mid-clavicular line on the right side and otherwise normal. The blood pressure was 126/70. Abdominal examination revealed liver dullness in the left upper quadrant and tympany suggesting the presence of the stomach in the right upper quadrant. The rest of the physical examination was normal.

The x-ray findings showed normal heart and lungs in situs inversus. A barium enema showed that the same condition existed abdominally.

The patient's convalescence was uneventful. Before his discharge from the hospital he was advised as to the abnormal position of his viscera. He was told that if he ever had pain in the abdomen he should advise his attending physician that his appendix was on the left side.

On February 4, 1943, he was again referred to the hospital. This time he was complaining of epigastric pain which had localized to the left lower quadrant. On admission he was able to advise the surgeon on call of the left-sided position of the appendix. This was of great aid in diagnosis. Physical examination revealed localized tenderness associated with muscle spasm and rigidity in the left lower quadrant

\* From the Surgical Service, Station Hospital, Truax Field, Madison, Wisconsin.

at a point which was analogous to McBurney's point on the right side.

Laboratory findings on this admission were:

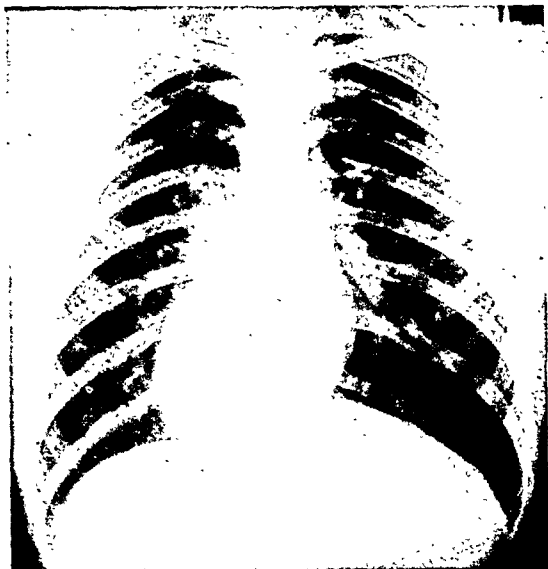


FIG. 1. Chest in Case 1 showing dextrocardia.

Red blood count 4,320,000; white blood count 10,150; hemoglobin 80 per cent. The differential blood count showed 71 per cent polymorphonuclears and 27 per cent lymphocytes. The urine examination was normal.

He was explored through a left McBurney incision under spinal anesthesia and the appendix was removed.

The pathological diagnosis of this appendix was "acute ulcerative and suppurative appendicitis with fecalith, and fibrous obliteration of the terminal end of the appendix."

His convalescence was completely uneventful.

**CASE II.** A twenty-three year old white male was admitted to this hospital April 4, 1943, complaining of a swelling in the left femoral region of seven years' duration. When the pain in the femoral region became severe there was associated nausea and vomiting. Physical examination revealed a right-sided heart which was otherwise normal and a soft, tender, cough-propelled mass in the region of the left femoral ring. X-ray examination of the chest and abdominal viscera with barium enema established the diagnosis of situs inversus totalis. During the course of his hospital stay the hernia was repaired.

**CASE III.** A twenty-one year old white male, was admitted to the hospital on March 28, 1943, complaining of pain in the right side of his chest. The patient stated that during a

routine examination while in high school the examining physician informed him that he had "heart disease" and was not to climb steps or



FIG. 2. Barium enema (postevacuation film) showing left-sided position of the appendix in Case 1.

exercise. The chest pain dates from this examination. The pain was described as a dull ache made worse by deep breathing. He complained of some dyspnea on exertion. The physical examination was negative except for the following findings: The apex beat of the heart was both visible and palpable just inside the right mid-clavicular line. The rhythm was regular. A systolic murmur without thrill was present at the apex. The murmur was obliterated by holding the breath in complete inspiration or expiration. There was no diastolic murmur. Liver dullness was noted in the left upper quadrant of the abdomen. Barium enema showed on x-ray a situs inversus coli. Chest plate revealed a dextrocardia. Electrocardiogram was essentially negative. The medical service concluded that the pain was not cardiac and that the systolic murmur was functional. He was discharged to duty on April 4, 1943, with a diagnosis of situs inversus viscerum totalis.

#### SUMMARY

1. Three cases of situs inversus totalis are presented. These represent the incidence in 15,374 hospital admissions, or one in every 5,124 admissions.

2. A case of left-sided, acute appendicitis is presented which had been previously diagnosed and substantiated by x-ray findings at this hospital.

3. The fact that the patient had been advised of his intestinal congenital anomaly was a distinct aid when his surgical condition arose.

4. It is of value to remark that the symptoms and signs in the case presenting appendicitis were at no time referable to the right side.

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TREATMENT of a contused bone consists in rest and cold applications, which exert a vaso-constricting effect, and thus limit oozing. If infection threatens, fomentations are applied. Oedema or fluctuation necessitates an incision down to the bone in order to reduce tension or, if suppuration has occurred, to allow the exit of pus.

The brief excerpts in this issue have been taken from "A Short Practice of Surgery" by Hamilton Bailey and R. J. McNeill Love (H. K. Lewis & Co. Ltd.).

# SALPINGO-OOPHORITIS AND APPENDICITIS IN PATIENT WITH CONGENITALLY ABSENT VAGINA, UTERUS AND LEFT ADNEXA\*

## CASE REPORT

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THE following case is reported because  
of the rarity of its type:

### CASE REPORT

This white female, aged thirty-one years, has been married for nine years. She was about 5 feet 1 inch in height, weighed 125 pounds; her breast development and other female characteristics were normal. She was Italian, her husband, Bulgarian, and she was apparently happy.

She had consulted several doctors to ascertain why she had not menstruated in her adolescence and early twenties. She was told that she had "some gland trouble" and needed "shots." And the patient was given these "shots" for several months, but she did not menstruate.

*Pelvic examination* revealed that this patient had no external vaginal orifice, but only a dimple at the site of the introitus. Rectally, no female genitalia were made out.

For the two months she experienced pain in the right lower quadrant which would come and then disappear, but on November 17, 1942, the previous recurrent pain became localized over McBurney's point. She vomited once that afternoon and appeared subacutely ill.

In giving her past history she told us of a thyroidectomy at the age of sixteen years, and that bronchial asthma had been present for several years. She had one sister, who was apparently normal, and four brothers, who were in good health. Her mother died of pulmonary tuberculosis. Her father was living and well.

On physical examination we found an old, wide, irregular thyroidectomy scar. Her blood pressure was 120/70; pulse, 100; temperature,

99.4°F.; respiration, 28. The chest presented many musical râles, but no fluid or consolidation. The abdomen was slightly distended and there was slight muscle spasticity in the right lower quadrant. No real rigidity was made out. The site over the McBurney point was definitely tender, so that the patient complained and cried when the area was palpated. The peristaltic sounds were present and slightly faster than normal.

Rectal examination revealed the presence of exquisite tenderness over the cecal area and the right adnexal zone, although no definite masses were discernible.

*Laboratory findings* were:

White blood cells.....	12,100
Neutrophils.....	79%
Segmented.....	76%
Band.....	3%
Eosinophils.....	1%
Lymphocytes.....	20%
Red blood cells.....	4,610,000
Hemoglobin.....	96%
	17.5 Gm.

Urine was essentially negative.

Because of the aforementioned complaints and findings a preoperative diagnosis of acute appendicitis was made. However, it was decided to make a midline incision to explore the pelvis thoroughly.

Complete absence of the uterus and the left adnexa was found at operation. However, the fossa of the right iliac bone revealed the presence of a deep fold of peritoneum which grossly resembled a remnant of the right broad ligament and which formed into a fold; and in this fold were found the ovary and tube, the appendix overlying the latter. The tube and the ovary were adherent by fine but firm

\* From the Norwegian American Hospital and Cook County Graduate School of Medicine.

adhesions; the ovary was thickened, fibrotic, and contained multiple follicular cysts, also one corpus luteum cyst which was bleeding.

fibrous throughout and has some small cysts up to 8 mm. size. Adherent to the ovary is the fimbriated end of the tube and the fimbriae

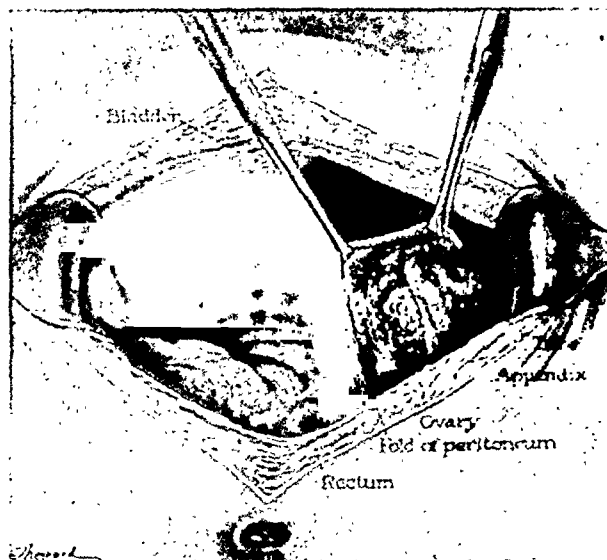


FIG. 1. Note the absence of uterus and left adnexa.



FIG. 2. Section of the ovary.  
X 215.



FIG. 3. Section of the tube. X 90.

There were many small peritoneal cysts on the fimbria and on the tube proper. The latter showed gross evidence of inflammatory disease. The appendix was free but fibrotic and injected. The above mentioned structures were removed and the abdomen closed.

The pathological report from the laboratory, reported by Dr. H. R. Fishback, is as follows:

Ovary, 4 by 2 by 1 cm., has a thick, greyish-yellow fibrous capsule. On section it is quite

are shortened and fibrous and inclose small cysts up to 8 mm. size filled with clear fluid.

Appendix: 4 cm. long by 5 mm. thick. It has a fat meso-appendix. On section the wall is 2 to 3 mm. thick and fibrous and the lumen stenosed.

Microscopic section of the ovary shows a hemorrhage surrounded and infiltrated by numerous young granulosa cells on a fibrous tissue base. Sections of the fimbriated ends of

the tube show the tube wall to be congested and somewhat thickened by fibrous tissue. The fimbriae are swollen and blunted. There is one thin-walled cyst lined by flattened epithelium which has a very thin fibrous wall.

*Diagnosis:* Hemorrhagic corpus luteum of the ovary; follicular cysts; fibrous change in the fimbriated ends of the Fallopian tube, fibrous changes in the appendix.

This patient had an uneventful recovery and in ten days left the hospital. She has been perfectly well since.

*Comment.* This case is interesting from several different aspects. The question of improper treatment for amenorrhea needs only a word to emphasize the value of complete pelvic examination and to warn one not to rely on hearsay.

The explanation for the inflamed tube and ovary in the absence of an exterior

vaginal orifice is a matter of deduction. Unquestionably, the inflammation was of endogenous origin. The question whether the recurrent salpingo-oopharitis caused secondary appendicitis by contiguity or vice versa remains as such. But do we not observe clinically that even upper respiratory infections such as tonsillitis may cause mesenteric adenitis? And that pneumococcus peritonitis following acute pneumonitis is believed to be metastasized via the Fallopian tube? And why may it not cause tubo-ovarian inflammation, be it of lymphogenous or hematogenous route?

We do not know the exact mechanism of spread, but clinically, we do see these organs become inflamed and causing symptoms in spite of the absence of an external vaginal orifice.



# OCCLUSION OF INFECTED PATENT DUCTUS ARTERIOSUS WITH CELLOPHANE

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AS more patients with patent ductus arteriosus are being operated upon successfully, it is becoming obvious that the ordinary types of ligature material are inadequate to maintain occlusion of a patent ductus arteriosus. This is particularly true of the infected cases. It is, therefore, the purpose of this paper to offer a better type of ligature material. Cellophane fulfilled the requirements of a satisfactory ligature material in the case we are reporting.

The idea of using cellophane was suggested to us by Dr. Richard Meade as the result of a letter received by him from Dr. Robert Gross. The principle was based upon the experimental work of Pearse. Holman, in his discussion of Pearse's paper, first proposed that the cellophane might be a suitable ligature material for the occlusion of a patent ductus arteriosus.

Graham, Gross and Jones, Dolly and Bullock have all expressed the opinion that ligation alone with the ordinary types of ligature material is inadequate to obtain complete permanent obliteration in all cases of patent ductus arteriosus. This is particularly true of the infected cases with large irregularly shaped vegetations within the lumen of the ductus arteriosus. The authors know of one case in which the patient had to be operated upon a second time because ligation with silk ligatures at the first operation failed to accomplish complete and permanent obliteration of the ductus arteriosus.

The case we are reporting was a particularly favorable one to determine the value of cellophane as an occluding material. In the first place, the patient was an

adult woman, age twenty-eight years. In the second place, she had had subacute bacterial endocarditis and endarteritis for at least seven months. Both of these factors tend to make the likelihood of failure or recurrence much greater than in young patients who are not infected. Furthermore, the postoperative course of the patient clearly demonstrated that braided silk ligatures alone would have failed to accomplish a permanent occlusion of the ductus arteriosus.

## CASE REPORT

The patient was a poorly nourished white woman who weighed only eighty-five pounds. She was twenty-eight years of age, married but had no children. The diagnosis of patent ductus arteriosus had been made when she was only three years of age. She had been a semi-invalid all of her life. For seven months prior to being seen by us she had had symptoms of superimposed, subacute, bacterial endocarditis and endarteritis. The presence of the infection was evidenced by increasing fatigue, daily fever of 102° to 105°F., night sweats, cough, and loss of ten pounds of weight. One of the outstanding features of her case was the repeated showers of emboli which caused pain in the chest, hemoptysis and hematuria. On examination she was found to have a generally enlarged heart with a loud "machinery" murmur which was systolic at the apex, systolic and diastolic in the pulmonic area. Her blood pressure was 110/40. Repeated blood cultures before operation revealed non-hemolytic, non-viridans streptococcus. The blood Wassermann test was negative.

She was given several blood transfusions and sulfonamide therapy prior to operation. The operation was performed under intratracheal cyclopropane anesthesia. The incision was

\* Dr. Harper is now a Major in the Medical Corps.

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## Editorials

### THE OBSTRUCTED GALLBLADDER

WHY all this discussion about the proper treatment for "acute cholecystitis"? One says: "Operate early for fear of extension of the process to perforation and peritonitis." Another says: "Delay operation because in the acute phase operation is difficult and dangerous, and the patient's condition needs to be improved."

Often, in the discussion, "operation" is not defined but it is usually understood to mean radical cholecystectomy simply because this is the accepted way to handle cholecystitis.

And what is "early"? Is it "early" when a patient who has had gallstones for years suddenly develops a palpable, tender gallbladder? And do the advocates of "early" operation (cholecystectomy) believe that adhesions and sclerosis of years standing are softened in a few hours by the acute process, to such an extent that an operation, which would otherwise be a hard struggle, now becomes easy and safe?

It seems to be a passion with many surgeons to reduce all procedure to standards set by authority and statistics. Once I was told by a "Chief," "I want only standard, accepted methods used in this clinic." Is it more important to use standards than brains?

One recent editorial writer bemoans our

chaotic ideas as to the treatment of acute cholecystitis and ends with a wish for better things; another advocates early operation but decides that about the only way to get a chance to do it is to educate the profession and the public. There is not much time to educate a patient with an acute condition of the gallbladder. However, I do agree that *the profession should be educated*. But shall we operate at once in every case that looks like biliary colic? Every patient with symptoms suspicious of gallstones should have cholecystography, and every patient with proved gallstones, who is not the poorest kind of risk, should be operated upon before acute cholecystitis develops. That is the early operation that counts, and even then many will not be early enough.

It seems that in the field of cholecystitis most of us beat about the bush, often stubbing the toe on the obvious culprit—the obstructing stone—but still keep on beating.

Years ago Denton discovered that blockage of the cystic duct, usually by a stone, is the cause of acute cholecystitis, through a two-fold action: (1) checking the return circulation, and (2) increasing pressure by preventing outflow of secretions and exudates. Of course this leads to edema and inflammation—often gangrene, infection and perforation.



the vessel and an eventual obliteration of the lumen. As the process continues there comes a time when the intima is involved and destroyed, shutting off the vessel completely.

We discussed the use of cellophane with Dr. John Alexander. He raised the question of two possible objections, one being that the intense reaction might involve the recurrent laryngeal nerve which lies in juxtaposition to the ductus arteriosus. The question was discussed with him as to whether such a reaction could cause a permanent paralysis of the left vocal cord. The other objection was that the intense reaction and subsequent fibrosis might cause a permanent narrowing of the aorta. Neither of these mishaps occurred in our case but they should certainly be thought of as a possible complication.

#### SUMMARY

A case of patent ductus arteriosus in an adult woman, complicated by long standing severe subacute bacterial endocarditis and endarteritis is reported. The patent ductus arteriosus was occluded by ligating it with two silk ligatures and then wrapping cellophane loosely about it. The clinical postoperative course of the patient demonstrated the fact that the cellophane was responsible for the final complete occlusion

of the patent ductus arteriosus. For the first two weeks the murmur and symptoms disappeared only to reappear and persist until two and one-half months had elapsed from the time of operation. The murmur and symptoms then completely disappeared and the patient has remained entirely well to date, one and one-half years after surgery. The cellophane was thought to be responsible for the final complete and permanent occlusion of the patent ductus arteriosus.\*

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\* Since this report was written the patient has given birth to a normal child. She had no trouble at the time of the delivery and has had no trouble since the delivery.



If you are one of those restless souls who cannot stop with a simple life-saving procedure, more can be done with little increased risk, but not by slashing the patient open and digging in a deep, dark and dangerous hole.

It is safe, however, to work inside the gallbladder. With the help of a focusing headlight, and using the electrosurgical unit, the mucosa of the gallbladder can be destroyed then and there by fulguration. If not completed the first time, the job can be finished later by the use of the coagulating current through a transurethral resectoscope in the sinus. Destruction of the mucosa results in obliteration of the gallbladder. The mucosa having been destroyed, it is no more necessary to remove the wall of the gallbladder than the wall of an abscess.

Injection of radiopaque material (diotrast) into the cystic duct, or into the sinus later, will tell (1) if the obstructing stone has been removed, (2) if all the gallbladder mucosa has been destroyed and (3) the condition of the hepatic and common ducts.

These last few paragraphs represent an ax of mine which I do not propose to grind further here. *The vital and urgent need is to relieve the pressure in the obstructed gallbladder.*

I am tempted, however, to present another conservative measure for handling the obstructed gallbladder. It, as well as the first method given, is a modification of Pribram's "Mukoklase," only slightly more risky than the other:

Split the gallbladder laterally far enough to remove the obstructing stone. Do not plunge for the cystic artery or try to dissect the duct. The duct has been located by splitting on the comparatively safe lateral aspect. Trim away redundant parts of the gallbladder but leave enough for a good cuff. Clamp and coagulate bleeders cut across in the wall. Thoroughly fulgurate the mucosa with the electrosurgical unit. The gallbladder should be split no farther than necessary to relieve the stone, preferably leaving a short funnel at the bottom. The mucosa here, however, should be fulgured. Set a medium tube (large catheter) into the funnel-shaped lower end of the gallbladder or the cystic duct, and sew the edges of the cuff over it all the way up. The final result will be obliteration of the gallbladder, accomplished more easily and safely than by excision.

But first and above all the obstruction must be relieved to save life. The patient can be cured later by radical cholecystectomy if you will.

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## THE TREATMENT OF WAR WOUNDS OF THE PERIPHERAL NERVES

THE conflict that is now raging will no doubt, as in the first World War, produce a large number of bullet and high explosive wounds of the upper and lower extremities. During the last war, the use of chlorine (Carrel-Dakin) solutions in the treatment of suppurating or probably infected wounds, and the procedure of wide extirpation of lacerated and torn tissues, resulted in the prevention of many infections and of greatly improved wound healing. However, the experiences of the first World War showed that of the large number of wounds of the peripheral nerves of

the upper and lower limbs, the neural lesions were sometimes produced by the surgeon. They resulted either from the wide excision of injured tissues without due regard to large nerve trunks in the neighborhood, or possibly due to a lack of exact knowledge of the course of the large nerves in the extremities.

This may appear to be an unjustified criticism of some of the surgery that was done. The writer had occasion to operate upon a large number of soldiers with injuries of the peripheral nerves after they had been invalided home from the battle

A few of us not hooked by the belief that every inflammation must be primarily infective acted on Denton's findings in our practice and teaching. In almost every case of acute cholecystitis a stone can be found blocking the cystic duct; failure to find it in a narrow duct does not prove that it has not been there recently. Even in absence of a stone the duct will be blocked by inflammatory reaction.

For clarity of understanding, then, of the essential etiology and pathology, and consequently, of reasonable treatment, let us drop the term, "acute cholecystitis," call it "*the obstructed gall bladder*,"—and act accordingly.

A patient of middle age or past (usually harboring stones for years) develops "acute cholecystitis." Previously it has been called "biliary colic" or even "nervous indigestion." She has pain, tenderness and spasm in the upper abdomen, leucocytosis, vomiting, fever, maybe obstipation, maybe chills, maybe jaundice.

Effortless examination often reveals only muscle spasm in the right upper quadrant. But the right kind of an examination will usually demonstrate a mass below the liver, which, with inspiration, will gently slip under or against the hand held lightly on the abdomen. Time and patience, and the greatest effort, must be used because this is the most important sign as to the trouble and what to do about it, that is, if you use the minimum of pathological knowledge and common sense, and forget every article written, including this one. This sign will tell you, not whether you have acute cholecystitis, hydrops, gangrene, empyema or perforation; it will tell you that you have obstruction of the gallbladder, and yell for relief of that obstruction.

Usually this sign can be verified after the patient has had an anesthetic, even sedation and novocain. If after spinal anesthesia you can not palpate an obstructed gallbladder, you have something else.

Here I wish to point out the diagnostic

advantage of a heavy dose of morphia following a careful first examination. This may allow definition of the mass. It may be against the rule; but reason, not rule, should be followed. It is so important to make the decision as to whether there is a definite mass below the liver, descending with inspiration, that it may even be worth while to give intravenous pentothal anesthesia for assistance to this end.

If such a mass is present, it is almost certainly an obstructed gallbladder. *The obstruction should be relieved in the shortest possible time by the most direct route.* There is no need for long preparation. Saline and glucose may be administered while you are working.

Spinal anesthesia or novocain and intravenous pentothal may be used.

Make a small incision below the liver margin over the gallbladder, perhaps a little above the mass because distention pushes the fundus downward. (Remember this, too, in diagnosis.) Furthermore, the fundus may be buried in adhesions, among which an angel will not tread. They may be plugging a perforation. If the fundus is not adherent, it may be delivered through the small incision. Now everything is under control. It is the simplest matter in the world to relieve the dangerous intravesicular pressure and save the patient.

If the fundus of the gallbladder will not deliver readily, and everything is covered by adhesions, open into the gallbladder below the liver margin, tearing down no more of the adhesions than necessary for identification of the gallbladder.

Aspirate, open the vesicle, evacuate contents, search inside the gallbladder with focusing headlight, ribbon retractors and sucker for the obstructing stone. If successful in removing this, you have loosened the key log in the jam, and drained the whole biliary system as well. Even if the obstructing stone cannot be removed at once, the back pressure having been relieved, it may loosen later; or perhaps it can be softened by Pribram's alcohol-ether application.

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# Original Articles

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## PARALYTIC SCOLIOSIS

### AN ANALYSIS OF FIFTY-ONE CASES

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THE treatment of structural scoliosis of whatever origin has always been a serious problem. The results of treatment are still very far from satisfactory, although considerable progress has been made. Modern, comparatively simpler and somewhat surer measures have replaced the older methods of therapy. In view of the fact that there is no cure for scoliosis, in the sense of a complete restitution to the anatomical normal, treatment is necessarily limited to the following two objectives: First, and perhaps the more important, is the prevention of further increase of the deformity; second is the improvement or reduction of the curvature. With this specific goal in mind we may say that idiopathic and many of the other non-paralytic types of structural scoliosis may be fairly well controlled. We can expect that in the majority, perhaps in 70 to 80 per cent of the mild and moderate cases, through the use of one or another of several well established systems of treatment, the scoliosis may be arrested, or occasionally even permanently improved.

Scoliosis complicating acute poliomyelitis is a very much more troublesome problem than that of idiopathic and non-paralytic curvatures. The difficulties are due to many factors, each of which arises from or is related to the poliomyelitic disease. The features or characteristics of paralytic scoliosis which merit special comment, because they influence our concept of the etiology and the modalities of therapy, are the following:

*The Plastic State of the Tissues.* A patient who has had an attack of infantile paralysis has had an acute illness which often depletes the entire system of strength and resistance. Many of the muscles are partially or completely paralyzed. The circulation, especially in the legs, is often visibly poor. There are periods varying from months to years during which the patient is physically inactive even to the extent that he does not stand or walk, either because of the degree and extent of the paralysis, or because of the use of special apparatus or reconstructive surgery. As a result of the above circumstances the muscles and ligaments may be atrophied, and either stretched or contracted. The bones may be decalcified with decidedly diminished resistance to deforming stresses. In this weakened and plastic state all the bones, and particularly the vertebrae, are readily susceptible to structural alterations and may and do become deformed.

*Onset.* Paralytic scoliosis appears insidiously. Its existence and even increase may not be recognized because they are overshadowed by more evident disabilities of the extremities which urgently require our attention.

*Static Imbalance.* There is a manifest static imbalance in poliomyelitis because of the unequal involvement of the muscles of the trunk and especially those of the pelvi-femoral groups.

*Progress of Paralytic Scoliosis.* The deformity of paralytic scoliosis usually increases slowly over a period of several

fronts, and occasionally there was indubitable evidence that complete interruption of the functions of large nerves such as the ulnar, musculospiral, sciatic or external or internal popliteal had followed immediately after the mass extirpation of lacerated tissues.

Large nerve trunks, even if they traverse or are in the immediate neighborhood of an area of lacerated tissue, may be preserved with safety even when much torn muscle tissue has to be removed surgically. Large, uninjured nerves offer considerable resistance to infection, and their preservation will not greatly, if at all, increase the dangers of a secondary wound infection. Moreover, a large uninjured nerve trunk may be preserved even though it traverses a region in which infectious agents have been implanted or even in an actual area of suppuration. Therefore, especially with the modern sulfathiazole treatment of wounds, every effort should be made by the surgeon to safeguard large nerves that have not

been injured or that have been only slightly traumatized.

Such a course may diminish the number of cases in which secondary suture of divided nerves becomes necessary. Especial care should be taken of these nerves in which regeneration after nerve suture is poor, e.g., the ulnar nerves in the upper and the popliteal nerves in the lower limbs.

It is to be hoped that the follow-up of patients, in whom divided nerves have been secondarily sutured and the cases in which autotransplants have to be used in order to bridge nerve defects, will be better after this than after the first World War. After that conflict, the efforts of a small group of neurological surgeons to organize an efficient follow up in these patients, were not successful. As a result, our knowledge is still meagre of the final results of the large number of operations on individuals in whom nerve defects had to be bridged by autogenous nerve transplants.

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of a paralyzed limb. The size of the bone may be reduced in length and thickness. In fact, a bone may be retarded in growth

tension which in the normal state would be inconsequential are adequate to initiate a scoliosis in poliomyelitis. A shortened



FIG. 3. W. E., 1939. Film made several years after fascial reinforcement of abdominal wall and lumbar spine fusion; scoliotic deformity has increased to a very severe degree.

so that it may be several inches shorter than the corresponding bone in the well limb. The cortex may be so thin that it can be easily indented, cut readily with a scalpel and bent manually to any position. On section the marrow appears pale and the bone lamellae thin. It is my belief that in paralytic scoliosis the vertebrae are not only in a plastic state from demineralization but are weakened structurally from trophic changes. Under these pathologic conditions the spinal column gives way to deforming forces and a rotary lateral curvature ensues. Abnormal stresses and

leg in an otherwise normal child seldom causes scoliosis. In fact, 14 per cent of the population has some inequality in the length of the legs, but this disparity in length does not give rise to a scoliosis unless there is some additional physical defect or complication. In a normal child support of an arm in a shoulder spica, for instance, for a fracture at the shoulder or in the arm, would cause no concern about the possibility of the development of a scoliosis. But in a child afflicted with poliomyelitis the wearing of a plaster shoulder spica and the consequent and associated malposition

years. Occasionally, the curvature remains mild. Generally speaking, the more extensive the paralysis the greater will be

“razor-back” or kyphoscoliotic type. The deformity of the spinal column may increase even after an extensive and techni-



FIG. 1. W. E., paralyzed in 1923. This film made in 1928 shows a comparatively mild scoliosis.



FIG. 2. W. E., 1932. Two years after thoracic spine fusion; scoliosis has markedly increased.

the curvature of the spine. A particular feature of paralytic scoliosis is the tendency, after a stationary period of sometimes several years, for the curvature suddenly and without recognizable cause to increase and to become rapidly severe. Such an abrupt aggravation of the curvature rarely occurs in the idiopathic variety except after an exhausting illness, such as diphtheria, pneumonia or typhoid fever, which puts one on his guard and permits one to institute preventive measures. Paralytic scoliosis may even increase while the patient is undergoing supportive or even corrective treatment. Too often the curvature advances to a severe, so-called

cally seemingly adequate vertebral fusion, especially if the postoperative care is not continued for several years.

*Trophic Changes.* We are all aware of the great tendency in poliomyelitis to laxity of the soft tissues, particularly the ligaments, and to demineralization of the bones. These conditions result in a plastic state, referred to above. There is still another cause for the plastic state, namely, trophic disturbances in the bones from disturbed innervation and impoverished circulation. Trophic changes such as bluish discoloration and ulcerations are often evident in the skin of the legs. Trophic changes are equally common in the bones

histories of fifty-one cases treated in recent years on the various orthopedic services at the Hospital for Joint Diseases. It

our problem. A study made by me several years ago and my present impression lead me to believe that scoliosis complicates



FIG. 6. A. C., 1942. Five years after spine fusion and continuous support; deformity has increased to a "razor-back" scoliosis.

would probably have been better had each case been analyzed and evaluated by the original observer. Yet the study has yielded information which appears to apply to all of the cases on whatever service and under whatever therapy, and represents a cross-section of our experience with this deformity. Conference with my colleagues has shown that they share with me a profound pessimism about the results of the present treatment, and an enthusiasm for more aggressive therapy.

**Incidence.** It is difficult to obtain entirely accurate statistics on this phase of

poliomyelitis in only about 5 to 10 per cent of the cases. Yet in a recent study by Colonna and Von Saal\* the authors found an incidence of 30 per cent, although they considered the percentage surprisingly high. The incidence, at its lowest is still sufficiently high to warrant continuous vigilance in the care of a poliomyelitic patient.

**Sex.** Paralytic scoliosis affects boys and girls about equally. In my present

\* COLONNA, PAUL C. and VON SAAL, FREDERICK, A study of paralytic scoliosis based on five hundred cases of poliomyelitis. *J. Bone & Joint Surg.*, vol. 23, pp. 335-353.



of the trunk may frequently lead to a scoliosis, as it did in Case iv of the present series.

more light will be shed on it in the future. It is not enough to say that a given physical impairment or defect causes scoliosis,



FIG. 4. A. C., paralyzed in 1931. This film made in 1932 shows a mild right dorsal curvature of the spine.

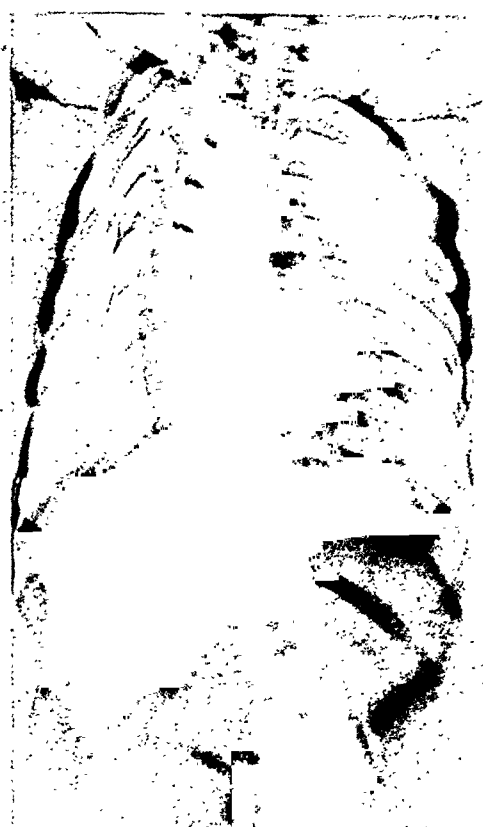


FIG. 5. A. C., 1937. The patient had an abdominal fascial operation and continuous support of back, but scoliosis increased.

*Unknown Etiological Factor.* A completely symmetrical distribution of muscle involvement in poliomyelitis is almost never present. Thus, muscle imbalance is the rule. This condition and all the others above mentioned, trophic changes, contractures, leg shortening, faulty postures, and so forth, can produce a scoliosis. Yet in the vast majority of poliomyelitic patients these disturbances are present but a scoliosis does not develop. We must, therefore, assume that in paralytic scoliosis, and actually this is true of all types of scoliosis, there is still another factor, as yet undiscovered, which initiates or influences the appearance and development of a curvature of the spine. I invite an open mind on the question of etiology, not to confuse the issue, but in the hope that

for many patients with the identical defect do not develop scoliosis. What we have been calling causes are probably only contributory elements, the real cause of scoliosis remaining undiscovered.

From the above observations it is, I believe, apparent that the treatment of paralytic scoliosis is essentially symptomatic and empirical. The treatment aims to correct mechanical derangements, wherever discovered, in the back, chest, abdomen or the extremities, and to reinforce the resistance of the vertebrae by fusing them over a variable segment of the spine. The elements requiring treatment can best be brought into relief by an analysis of the salient characteristics of paralytic scoliosis. With this in mind I have reviewed the

come under my care. In this connection we must note a very significant finding, namely, a very high incidence of paralysis

type of curve was indicated in thirty-four of the fifty-one cases. Of this number (thirty-four) fifteen had right dorsolumbar



FIG. 6. D. T., 1942. Spine fusion done in 1939; deformity has increased considerably since then.

of the abdominal muscles. Abdominal paralysis was recorded in thirty-eight of the fifty-one cases, nearly 75 per cent. This figure is undoubtedly low since abdominal paralysis may have been present in some of the other cases but not recorded. The percentage of abdominal paralysis is so high that it may be seriously questioned whether this is perhaps not the dominant factor in the development of the spinal curvature. Weight is added to such an assumption by the fact that most of the curvatures in the present group were dorsolumbar in type, the convexity of the curve corresponding generally to the side of the paralytic or weakened abdominals.

*Types and Degree of Curvature.* The

curves and eight left dorsolumbar curves. Thus, in two-thirds of thirty-four cases there was a single long curve involving most or all of the dorsal and lumbar vertebrae. The degree of the curvature was indicated in thirty-eight cases. Of these only two were mild, five were moderate and thirty-one, or 80 per cent, were severe, and many of these had "razor-back" deformities. The great frequency of the severe curvatures renders it all the more imperative that paralytic scoliosis be recognized early and treated vigorously.

*Treatment Applied.* From our knowledge of the requirements for the surgical repair and reconstruction of paralytic deformities, we can readily appreciate the

series of fifty-one cases there were thirty females and twenty-one males. This difference is not very marked and would, I am sure, be reduced in a larger count.

apparent. Yet in this unselected series of fifty-one cases all of the patients, with but one exception, had a very extensive distribution of muscle paralysis. Many of



FIG. 7. D. T., paralyzed in 1931. This film made in 1936 shows a mild scoliosis.



FIG. 8. D. T., 1939. Deformity worse than in 1936 despite continuous and adequate protection of the back.

*Time of Onset of Paralytic Scoliosis.* Our records show that in twenty-seven of the fifty-one cases, slightly more than 50 per cent, a scoliosis was recognized within five years of the acute onset of the poliomyelitis. In one case it was six years and in another ten years after the acute attack before a scoliosis was discovered. In twenty-two cases the time of recognition of the scoliosis is not recorded. The significance of these figures lies in the need for anticipation of the possible appearance and the early recognition of a scoliosis to permit the most effective application of corrective therapy.

*Muscle Paralysis.* Theoretically, scoliosis might be found in poliomyelitic cases in which there is such mild involvement of the muscles clinically that the paralysis is not

them had involvement of several limbs and not a few had paralysis in all the limbs. Many of the patients had so much muscle paralysis that they could not get about except by the combined use of one or two leg braces, spinal supports and crutches. The scoliosis was only a part of a picture of generalized and extensive paralysis with multiple deformities. One is naturally inclined to the conclusion that scoliosis should be expected when there is an extensive muscle paralysis. Conversely, when there is only limited and isolated paralysis, especially in one limb, there is little likelihood of the appearance of a scoliosis. I have no available statistics on this latter point but believe it to be true from a mental review of the cases which have

## CASE REPORTS\*

**CASE I.** William E., twenty-four years old, was paralyzed in 1923 at the age of five years. Originally, he had very extensive involvement of all of his limbs, the back and abdomen. He received the orthodox treatment and gradually improved. In 1928, he had a mild scoliosis. (Fig. 1.) He was treated for this by preliminary traction on a convex frame and a fusion operation in the lumbar area. Subsequently, he was adequately and continuously protected by plaster jackets and corsets. However, the deformity increased, and in 1930 he had a fusion operation on the thoracic segment of the spine followed by prolonged bed rest and immobilization of the back by plaster jackets and later a celluloid corset. The deformity continued to increase and by 1932 he had developed a razor back. (Fig. 2.) The spine fusions had failed to arrest the scoliosis. In 1932, he had fascial reinforcement of the abdominal wall, and a revision operation on the lumbar area for a possible pseudoarthrosis. The lumbar fusion was found to be solid throughout. The deformity continued to increase and in 1939 (Fig. 3) the scoliosis was far worse than in 1932. In retrospect the management of this case might have yielded a happier result had the abdominal wall been reinforced and the entire spine fused in 1928 when the scoliosis was mild.

**CASE II.** Anthony C., thirteen years old, was paralyzed in 1931 at the age of twenty-two months. He has been continuously under my care. Originally, he had involvement of all his limbs, the abdomen and the masseter muscles. He was treated by the orthodox system and gradually improved. Two years after the onset of the poliomyelitis a mild right dorsal curvature was observed. (Fig. 4.) Shortly thereafter an abdominal fascial reinforcement was done in the hope that it would arrest the progress of the scoliosis. His general condition at this time was very poor and did not warrant a spine fusion operation. Hence, the scoliosis was treated by the use of supportive apparatus. He was sent at this time to a convalescent home where, under a regime of forced feeding and much bed rest, his health improved considerably. The scoliosis, however, increased and four years later was quite severe.

At this time he had a fusion operation on the thoracic vertebrae and thereafter uninterrupted support of the trunk. The curvature increased some more (Fig. 5) requiring a resection of the ribs on the convex side which had become sharply angulated. He is still wearing a spinal brace. In this case none of the measures employed served to arrest the scoliosis, and our treatment of this deformity has been a complete failure. An x-ray film made in 1942 (Fig. 6), five years after the spine fusion shows a further increase of the deformity.

**CASE III.** Doris T., fourteen years old, came under my care when she was one and one-half years old for a congenital bilateral dislocation of the hips. The dislocations were fortunately readily reduced. One year later she had an attack of poliomyelitis involving chiefly her lower limbs for which, in the course of time, a bilateral astragalectomy was required. Five years after the onset of the poliomyelitis a mild right dorso-lumbar scoliosis was discovered. (Fig. 7.) She was promptly treated by traction on a convex frame and a thoracic spine fusion. Subsequently and continuously up to the present time she has had support of her back. We used at first plaster jackets and then a celluloid corset, and latterly a spinal brace. The curvature gradually grew worse (Fig. 8) and in 1939 the lumbar area was fused. Since then the curve has increased some more. (Fig. 9.) In a recent examination there seemed to be some weakness of the right abdominal muscles. This abdominal weakness must have been overlooked and may, perhaps, account for the continuous increase in the curvature. The spine fusions certainly failed to check the scoliosis. Perhaps the whole of the lumbar as well as the dorsal segments of the spine should have been fused when the scoliosis was first observed.

The preceding review of our experiences with paralytic scoliosis in a group of fifty-one unselected cases, and especially the analysis of the results of the use of the spine fusion operation for this deformity, presents a very discouraging picture. The high percentage of failures would tend to give us an attitude of defeatism were it not for the fact that the poor results from current methods of treatment challenge us to seek measures that will give us better

\* The author is indebted and grateful to Drs. Mayer, Jahss, Sonnenschein, Zadek and Milch for permission to include some of their cases in this study.

multiplicity of procedures that were needed and instituted in this group of fifty-one disabled individuals. There were myotomies, tenotomies, astraglectomies, Hoke stabilizations, tendon transplants, tenodeses, arthrodeses, osteotomies of all varieties, leg lengthening, abdominal fascial reinforcements and spine fusions. I am happy to say that in practically all of the cases the operations, singly or in combination had a wholesome effect in returning to the patient some measure of independence in the use of the limbs, and security in standing, sitting and walking.

*Results of Spine Fusions.* Our specific interest in this study was to determine the effect of spine fusions on paralytic scoliosis. The results are disappointing because the percentage of failures was 80, that is, failure to arrest the scoliosis and prevent its increase, which is the chief aim in all therapy of scoliosis. The reasons for these failures are many but not each of them naturally is found in every case. Perhaps at this juncture the obvious fact that is sometimes overlooked should be emphasized, namely, that even in a perfectly fused spine the curvature may increase in much the same way as a solid limb of a tree may and does become bent, twisted and deformed from various forces of stress and tension and the force of gravity. In fusing a spine we only increase the resistance to the deforming forces but do nothing to eliminate those forces. It is true that in many cases deforming influences were minimized as when weakened abdominals were reinforced, a shortened limb compensated or a pelvic obliquity corrected. Yet even under these conditions much of the muscle imbalance and the static imbalance remained. In addition, the average spine fusion was not performed until five years after the onset of paralysis, so that the scoliosis frequently advanced to a considerable degree before the circumstances in the case demanded or permitted the spine fusion. Some of the patients travelled extensively from one hospital clinic to another before accepting the suggestion

of a spine fusion. Some were such poor surgical risks that delay in performing the fusion operation was imperative. In some cases the fusion did not include enough vertebrae, and in a few a pseudarthrosis was present. Analysis of the successful cases also gives no clue as to why treatment was successful in them and not in the others.

As was previously noted, there was an abdominal paralysis in a large percentage of the cases in this group. It might be anticipated from this fact that abdominal fascial reinforcement would yield a high percentage of success. Perhaps this would be true if it were performed early and in every case before the scoliosis advanced. Nevertheless, our figures, while covering only a small number of cases, give no such glimpse of success. Twenty-one of our patients had abdominal fascial operations. In fourteen of these there were also spine fusions. In this group there were three successes, six failures and unknown results in five cases. In the remaining seven patients in whom the scoliosis was treated by jackets and braces, without a spine fusion, there were two successes, three failures and two with unknown results. Apparently, the results without a spine fusion were about as good, or rather as bad, as those with a spine fusion. It is not intended to draw any sweeping conclusions from figures in such a small group of cases. Moreover, each deformity must really be judged by the associated lesions and the general condition of the patient.

In all instances in which a spine fusion was performed there was adequate pre-operative treatment by corrective jackets or traction on a convex frame to reduce the curvature to the potential minimum before fusing the vertebrae. From three to fourteen vertebrae were fused depending upon the type and degree of the curvature and the surgeon's judgment as to the requirements of the case. Most patients had a fusion of at least eight vertebrae performed in one or several stages.

inforcement should not be employed as a last resort, for it has very little value, if any, after a severe scoliosis has been established.

#### TREATMENT

The treatment of scoliosis itself involves two factors: (1) reduction of the curvature, and (2) strengthening or stabilization of the spine by a fusion operation.

*Reduction of the Curvature.* In my own practice the use of traction on the head and pelvis with the patient recumbent on a convex frame gives excellent results, results that are favorably comparable with, if not superior to, those obtained from more drastic measures such as turnbuckle jackets, and, in much less time. There are many advantages in the method of traction on a convex frame. The trunk is completely exposed and respiration is not impeded. By the use of blow bottles the amplitude of the respirations may be greatly increased, and with increased aeration of the lungs goes an improvement in the well being of the patient. The muscles of the trunk and extremities may be freely exercised. Recumbency in extension reduces the angulation of the ribs on the convex side of the curve. The flattening of the chest on the convex side is not increased, as happens almost invariably in a plaster jacket. The reduction of the curvature to the potential maximum is very rapid, and rarely more than a matter of a few weeks.

However, there are many other methods beside traction on a convex frame which will serve well in the reduction of the curve. A simple jacket applied in suspension may be very effective. A "straight" jacket applied with three point corrective pressure may certainly yield excellent improvement. Similarly, distraction jackets, segmented jackets and turnbuckle jackets may be used very effectively. Each surgeon will undoubtedly obtain the best results with the method in which he is most proficient. The important point is that the

curvature should be reduced as much as possible before the spine is fused.

*Spine Fusion.* It is my impression that we have been performing spine fusions in paralytic scoliosis much too late after its recognition. Knowing that in most instances the curvature will increase, a spine fusion should be contemplated as soon as a paralytic scoliosis is discovered. The parents should be apprised of that fact, and plans should be made to do the operation as soon as the patient's general condition and the requirement of the other paralyses and deformities will permit.

*Extent of Spine Fusion.* I think that the simplest rule is to extend the fusion from the upper to the lower transitional vertebra of the improved spine in a single curve, or from the uppermost transitional vertebra to the lowermost in a compound curve. The fusion may be done in one or several stages depending upon the technic employed, and the general condition of the patient. No fusion operation should last more than one hour, because these patients tend to react poorly and develop acidosis. Particularly is this true if the operation has been accompanied by much bleeding or excessive trauma. A spine fusion operation is one that requires the maximum of surgical talent. Since it necessitates the use of a certain amount of force and trauma to the tissues, the surgeon and his assistants must keep in mind not so much the administration of intravenous medication as the employment of accuracy, speed, dexterity and gentleness. Know your anatomy and treat the tissues lovingly. Subsequent to the operation the patient must be kept in bed for two to three months until the fusion is reasonably solid. The back should then be supported in a plaster jacket, a corset or a brace for several years to prevent any marked relapse. Some increase in the curve usually occurs when the patient stands up, but this can be reduced to a minimum if adequate support is maintained uninterrupted for several years.

results. Consequently, let us consider first, the prophylaxis, and secondly, the type of therapy which may yield improved results.

#### PROPHYLAXIS IN PARALYTIC SCOLIOSIS

*Early Recognition of the Deformity.* Remembering that paralytic scoliosis is likely to occur in an extensively paralyzed patient, we must be on the lookout for a spinal curvature. And having discovered a scoliosis we must never forget or overlook it in all subsequent treatments. Often a limp, a distortion of an ankle or a relaxed and drooping shoulder so engrosses the attention of the parents and the patient that they see little else. But we must not be diverted from our interest in the spine by what, at the moment, most concerns the family. In our examination we must note and record all the physical defects. A scoliosis, be it ever so mild, is a danger signal, for it may at any time, and very rapidly, become a conspicuous and incurable distortion of the whole trunk. Having found a scoliosis we must proceed methodically to prevent its increase.

*Maintenance of Symmetry of the Trunk.* Continuous effort should be made to keep the trunk in a symmetrical attitude. To accomplish this in a patient confined to bed one may have to use cushions, sand bags, traction on one or both legs or a plaster bed. If he is sitting a large part of the day, it may be necessary to adjust the seat, back, arms or foot pieces of the chair to prevent faulty posture. If the patient is able to stand or walk, a shortened limb must be compensated for by an appropriate lift. Leg braces, if worn, should be inspected periodically to make certain that malposition of the trunk is avoided. Crutches, when used, must be exactly right in length.

*Support of the Back.* In many instances the trunk may have to be protected against a tendency to a lateral or anteroposterior shift by employing supports such as a canvas corset, a celluloid corset, a brace or a plaster jacket.

*Reconstructive Surgery.* Most of the patients in this group of paralytics require reconstructive surgery. This should be performed as soon as it is reasonably certain that the phase of spontaneous improvement has passed. Stabilization of a dangle shoulder or ankle, correction of a genu recurvatum or pelvic obliquity or a flexion at the hip, the reinforcement of a weakened abdominal wall or a paretic quadriceps tend to improve stability and stance, and hence prevent the occurrence or the progress of a scoliosis. As far as possible the operation planned should be simple and not entail a prolonged convalescence. Complicated operations provide much opportunity for academic dissertations but afford little change for the patient's rapid recovery.

*Exercises.* Since inactivity in poliomyelitis rapidly leads to atrophy of muscles, relaxation of ligaments and demineralization of bone, the surgeon must constantly seek to prevent these effects by making the patient engage in exercises specially suitable for him. This is particularly indicated for those confined to bed or restricted by apparatus. This phase in the prophylactic program should preferably be directed by the surgeon himself who can best appreciate the type, degree and amount of bodily exercise that will be most beneficial to the given patient.

*Fascial Reinforcement of the Abdominal Wall.* Since there is paralysis or paresis of some part of the abdominal wall in the majority of cases of paralytic scoliosis, it is important that this muscle defect be recognized early and corrected or compensated by a fascial reinforcement. This operation, easily performed and generally successful, should be done as soon after the discovery of the abdominal weakness as the condition of the patient will permit. It certainly will give the patient a sense of greater security, will facilitate the more effective use of the muscles of the chest and back, and may prevent the occurrence of a scoliosis or at least its increase if it is already present. An abdominal fascial re-

# EFFICACY OF ULTRAVIOLET BLOOD IRRADIATION THERAPY IN THE CONTROL OF STAPHYLOCOCCEMIAS\*

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THE use of ultraviolet blood irradiation therapy as a safe and efficient control of acute pyogenic infections has been described by several workers in this field, notably Knott and Hancock,<sup>1,2</sup> Miley,<sup>3-5</sup> Rebbeck,<sup>6-12</sup> and Barrett.<sup>13,14</sup> Our findings have been in close agreement with the other workers, and have been reported as such with one exception, namely, the value of ultraviolet blood irradiation therapy in the treatment of staphylococcemias, in which we originally reported the failure of ultraviolet blood irradiation therapy to control the progress of staphylococemia in seven consecutive cases. Recently, we have observed complete recovery from staphylococemia in nine consecutive cases, and therefore wish to retract our original statement that we believed staphylococcemias did not respond well to ultraviolet blood irradiation therapy.

As the result of our original experience with seven consecutive failures, followed by nine consecutive recoveries of staphylococemia, following ultraviolet blood irradiation therapy, we naturally wished to find some reason for the marked difference in results, and in carefully going over the records of all sixteen individuals we found that in six out of seven cases of the original failure group, intensive sulfa drug therapy had been given before and/or after ultraviolet blood irradiation therapy was administered, whereas eight of the nine individuals in the recovery group had had no sulfa drugs whatsoever, that the ninth received a small amount of sulfathiazole only, and that before the development of a positive blood culture. This finding is

what might be expected after reading the report of Hancock,<sup>2</sup> whose eight patients suffering from septicemia received no sulfa drug therapy but recovered with ultraviolet blood irradiation therapy alone; similarly a double septicemia, reported by Rebbeck,<sup>11</sup> recovered following the use of ultraviolet blood irradiation therapy alone.

## TECHNIC

The technic of irradiating blood used by us in this work was originally devised by Knott, and has been described in detail elsewhere.

The clinical application of ultraviolet blood irradiation therapy consists of withdrawing a predetermined amount of venous blood from an individual, citrating it and immediately returning it to the same individual through a Knott hemo-irradiator, a precision machine which automatically exposes the patient's citrated blood to ultraviolet energy safely and efficiently, and returns it immediately to the vein from which it was withdrawn.

A detailed report of results observed following the use of this method in sixteen cases of staphylococemia follows:

## RESULTS IN STAPHYLOCOCCEMIAS

We have divided our results in staphylococcemias into two separate groups: the first consisting of seven consecutive failures of ultraviolet blood irradiation therapy to control the diseased process, six of whom received intensive sulfa drug therapy prior to irradiation, and the second consisting of nine cases of staphylococemia, all of whom recovered following ultraviolet blood irradiation therapy alone.

\* From the Blood Irradiation Clinic, Hahnemann Medical College and Hospital, Philadelphia.



## CONCLUSIONS

1. The results of the treatment of paralytic scoliosis have so far been very poor with only a small percentage of successes.

2. In all cases with extensive extremity paralysis one must be on the lookout for a scoliosis. This is particularly true if there is any abdominal weakness.

3. When a scoliosis is discovered, all treatment must be directed to maintaining the trunk in a symmetrical position. This may entail prolonged rest in bed, the use of restraining cushions and sandbags, a plaster bed, a canvas corset, a celluloid corset, a spinal brace or a plaster jacket.

4. Exercises should be employed wher-

ever possible to minimize muscle and bone atrophy.

5. If an abdominal muscle weakness is found, it should be corrected or compensated by a fascial reinforcement.

6. Deformities in the extremities, and particularly pelvic obliquity, should be corrected at the earliest possible time.

7. In all but the exceptional cases, in which the history shows that the curvature has existed for several years and has remained mild, a spine fusion operation should be performed. The operation should include all the elements of the major curves, and be followed by several months of bed rest and several years of protection and support of the back in a well fitting spinal corset or brace.



RECURRENT dislocations occur because the torn capsular ligaments have not healed, the articular surfaces being displaced easily and frequently. In most instances recurrence can be attributed to insufficient immobilization.

From "Fractures and Dislocations for Practitioners," by Edwin O. Geckeler (The Williams & Wilkins Company).

**Group I--Seven Staphylococcemias Not Controlled by Ultraviolet Blood Irradiation Therapy.** In this group six individuals receiving ultraviolet blood irradiation therapy alone, six were due to *Staphylococcus aureus* and three to *Staphylococcus albus*.

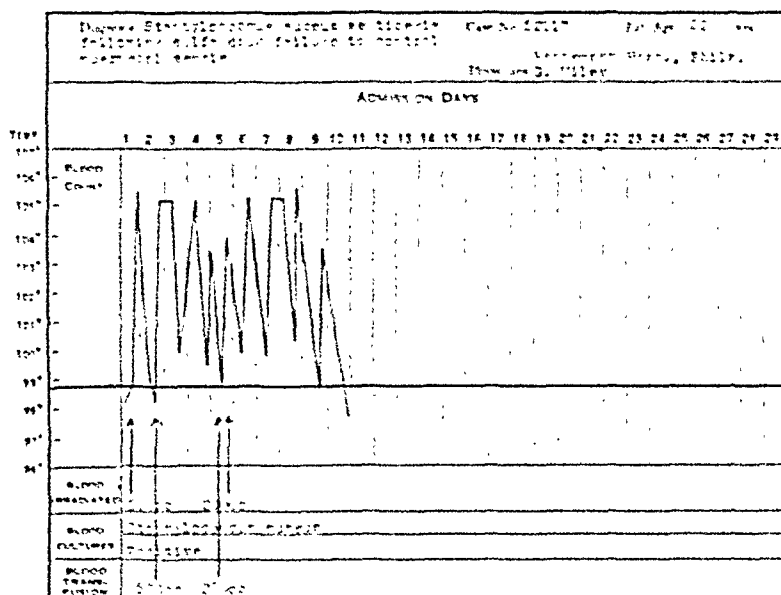


FIG. 1. (Group I.) Case 1. In this patient there developed a fulminating *Staphylococcus aureus* septicemia and staphylococcus pneumonia while the patient was being given intensive sulfanilamide and sulfapyridine therapy for puerperal sepsis. On transfer to this hospital ultraviolet blood irradiation therapy and whole blood transfusion failed to influence the course of the disease and the patient died.

received ultraviolet blood irradiation therapy following intensive sulfa drug therapy, five due to *Staphylococcus aureus*, and one to both *Staphylococcus aureus* and *albus*; the seventh, with *Staphylococcus aureus* septicemia secondary to bladder carcinoma complicated by right-sided atelectasis and empyema, received only ultraviolet blood irradiation therapy. In all seven there was a complete failure to control the staphylococchemia and all these patients died.

In Table 1 is shown the protocol of Group One tabulating the salient features observed to occur clinically in this group.

Peak temperature graphs illustrating the absence of beneficial effects in staphylococcemias of ultraviolet blood irradiation therapy used after intensive sulfa drug therapy failed are shown in Figures 1, 2, and 3.

**Group II--Staphylococcemias Controlled by Ultraviolet Blood Irradiation Therapy.** In this group of nine staphylococcemias

In all nine there was a complete control of the staphylococchemia and all nine patients recovered.

In Table II is shown the protocol of Group Two tabulating the salient features observed to occur clinically in this group.

Peak temperature graphs showing the relation of ultraviolet blood irradiation therapy to the subsidence of fever, coincident with generalized detoxification, in three of the individuals from Group Two are shown in Figures 4, 5, and 6.

#### CASE REPORTS

Six case history abstracts from Group Two are presented:

**CASE 1.** No. 81994. The patient was admitted November 16, 1942, complaining of severe pain and swelling in the region of her right ear. Physical examination revealed a marked edematous erysipeloid inflammatory process around the right ear, and some injection of the right ear drum. Her temperature was 100.0°F., pulse rate 120, and respiratory

TABLE I

No.	Hospital No.	Type of Staphylococemia	Primary Infection	Type of Sulfa Drugs Used	Number Blood Irradiations	Number of Hospitalization Days		Result
						Total	Post-Irradiation	
1	52117	Aureus	Staph. pneumonia, lung abscess	S* SP	2	7	7	D.†
2	Framingham Hosp. 65236	Aureus	Unknown	S SP	2	45	2	D.
3		Aureus and albus	Puncture wound of eye	S SP ST	4	15	15	D.
4	64501	Aureus	Prostatic resection area infection	ST	1	37	12	D.
5	48830	Aureus	Wound infection, sinus thrombosis following frontal sinus-ectomy	S NP	1	2	1	D.
6	60720	Aureus	Wound infection following operation for ingrown toenail	ST	2	13	9	D.
7	38082	Aureus	Bladder carcinoma, bilateral pyonephrosis, empyema, atelectasis, bronchial pneumonia	None	4	47	18	D.

\* Key:

S—Sulfanilamide

SP—Sulfapyridine

ST—Sulfathiazole

NP—Neoprontosil

† Died

TABLE II

No.	Hospital No.	Type of Staphylococemia	Primary Infection	Type of Sulfa Drugs Used	Number Blood Irradiations	Number of Hospitalization Days		Result
						Total	Post-Irradiation	
1	81994	Aureus	Marked erysipeloid inflammatory process of right ear	ST (before appearance of staphylococemia)	1	20	12	R.*
2	84630	Aureus	Incomplete septic abortion	None	1	16	11	R.
3	88168	Aureus	Incomplete septic abortion	None	2	19	16	R.
4	88167	Aureus	Incomplete septic abortion	None	1	10	9	R.
5	82484	Aureus	Incomplete septic abortion	None	1	20	7	R.
6	83141	Albus	Acute ulcerative rhinitis, acute suppurative otitis media, acute mastoiditis, incomplete septic abortion	None	2	39	17	R.
7	82702	Albus	Incomplete septic abortion, putrid endometritis, parametritis, pelvic peritonitis	None	2	12	7	R.
8	86768	Aureus	Post-measles upper respiratory infection	None	2	19	16	R.
9	50698	Albus	Postcesarean pelvic thrombophlebitis	None	1	33	11	R.

\* Recovered

examination on admission revealed a right-sided parametrial tenderness, normal temperature, pulse and respiratory rates. Routine

normal; the patient's toxic symptoms had almost completely disappeared. On the second post-irradiation day, April 19th, 250 cc. of

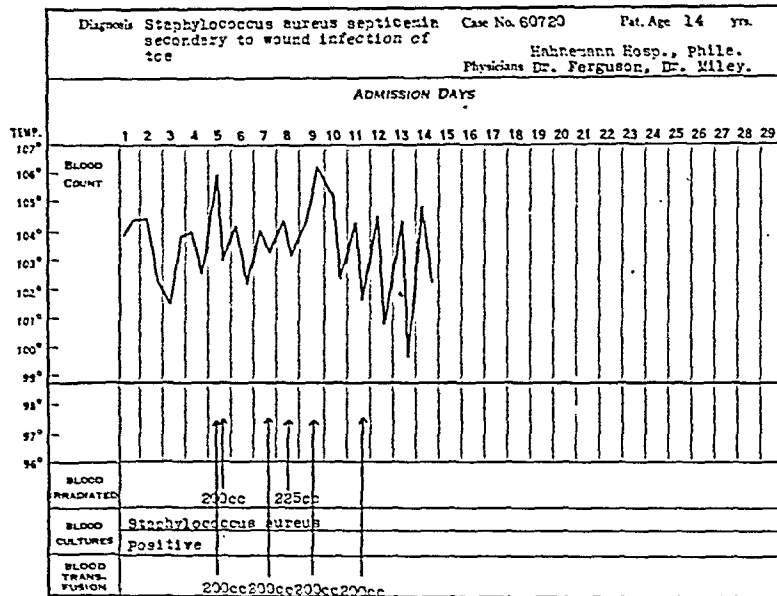


FIG. 3. (Group 1.) Case VI. This patient developed *Staphylococcus aureus* septicaemia following removal of an ingrown toenail by a chiropodist. Intensive sulfathiazole therapy failed to control this septicaemia, as did subsequent ultraviolet blood irradiation therapy and more sulfathiazole therapy with death as a final result.

hematological examination and urinalysis were negative; however, on the day following admission the patient's temperature rose to 102.0°F., her pulse rate to 104, her respiratory rate remaining normal; clinically, the patient appeared to be moderately toxic. Ultraviolet blood irradiation therapy was instituted at this time, April 15th, and a blood culture was taken in tryptose phosphate broth; this later proved to be pure culture positive for *Staphylococcus aureus*, with a rich golden pigmentation apparent in a subculture made on Loeffler's medium. On the following day the patient's temperature rose to 104.6°F., and she appeared more toxic than ever. Forty-eight hours after the initial ultraviolet blood irradiation the patient's condition had shown no improvement but had continued to deteriorate, and her temperature was 103.2°F. at 8 A.M., April 17th. At 9 A.M. a second blood culture was taken which was also pure culture positive for *Staphylococcus aureus*, which showed much less golden pigmentation in a subculture on Loeffler's medium than did the first culture. As soon as the culture was taken ultraviolet blood irradiation therapy was repeated, and within twenty-four hours following this second blood irradiation her temperature and pulse rate returned to

whole blood was given. On April 20th, a piece of placental tissue was passed. A blood culture taken on April 24th was negative. On April 27th, dilatation and curettage was performed, followed by no temperature rise whatsoever. The patient continued to convalesce uneventfully, and left the hospital on May 3, 1943, in apparently excellent condition, eighteen days after her original blood irradiation. At no time during this sixteen-day convalescent period did the patient's temperature rise above 98.6°F.

CASE IV. No. 88167. This patient was admitted October 30, 1942, to the septic ward, complaining of vaginal bleeding and crampy abdominal pains of two days' duration. Physical examination revealed a bilateral parametrial tenderness, and an enlarged edematous cervix; a diagnosis of incomplete septic abortion was made. During the first twenty-four hours of hospitalization the patient had two very severe chills, her temperature ranged between 99.2° and 100.2°F., her pulse rate between 108 and 140, and her respirations between 22 and 28; the patient was extremely toxic at this time. Urinalysis was negative; erythrocyte count 3,260,000, hemoglobin 11.1 Gm., leukocyte count 14,600 with 85 per cent polymorphonuclears and 15 per cent lym-

rate 24 at this time. Routine hematological examination and urinalysis were negative. Sulfathiazole was started, and given intensively

was confirmed by physical examination. Two days later the patient passed two large blood clots. The patient's temperature, which had

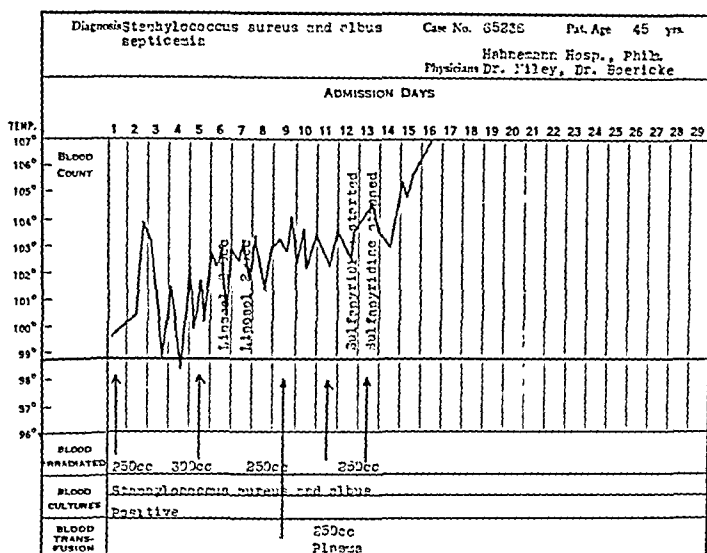


FIG. 2. (Group 1.) Case III. This patient was admitted to the hospital after two weeks of intensive sulfathiazole therapy following puncture wound of the eye; a fulminating *Staphylococcus aureus* *Staphylococcus albus* septicemia developed during this period of chemotherapy, and failed to respond during hospitalization to ultraviolet blood irradiation therapy, liposol and sulfapyridine.

for three days, during which time the patient's temperature rose to 103.0°F., her pulse rate to 124, and respiratory rate to 28, but finally fell to normal on November 19, 1942. The patient's erysipeloid lesion had improved, there was less injection of the ear drum, so sulfathiazole was discontinued. The patient ran an uneventful course for another three days, but on November 23rd her temperature began to rise again; this rise continued for forty-eight hours to 102.0°F.; the pulse rate rose to 110, at which time the patient suddenly became somewhat toxic. A blood culture taken at this time later proved to contain a luxuriant growth of *Staphylococcus aureus*. Ultraviolet blood irradiation therapy was instituted immediately after blood culture was taken. Forty-eight hours later the patient's temperature and pulse rate both fell to normal. Blood culture taken November 28, 1942, three days after blood irradiation, was sterile. The patient convalesced uneventfully, leaving the hospital on December 6, 1942, twelve days after a single blood irradiation.

CASE II. No. 84630. This patient was admitted March 10, 1943 to, the septic ward with a diagnosis of incomplete septic abortion which

varied from 98.0° to 99.8°F., fell to normal, and the patient was allowed out of bed. Forty-eight hours after being allowed out of bed the patient's temperature began to rise reaching 101.6°F.; her pulse rate rose to 112. The following day, March 15th, the patient became extremely toxic; her temperature rose again, this time to 103.6°F. Blood culture was taken and ultraviolet blood irradiation therapy administered. The blood culture, taken in tryptose phosphate broth, later proved to be positive with a profuse growth of pure culture *Staphylococcus albus*. On the first post-irradiation day, March 16th, the patient's temperature fell to normal and her toxic symptoms had almost completely disappeared. Forty-eight hours after blood irradiation the patient passed a large amount of secundines, and two days later dilatation and curettage was performed. The patient's subsequent convalescence was uneventful, blood cultures being negative thereafter, and the patient left the hospital March 26, 1942, eleven days after a single blood irradiation.

CASE III. No. 88168. The patient was admitted April 14, 1943, complaining of abdominal pain and vaginal bleeding. Physical

of the time that a positive blood culture had been present.

It is my opinion that this again illustrates the powerful protective effect that had continued to deteriorate slowly, and on January 23rd obstetrical consultation revealed the imminence of a threatened abortion. On January 26th, drainage from the ear had entirely stopped, and the mastoid process had

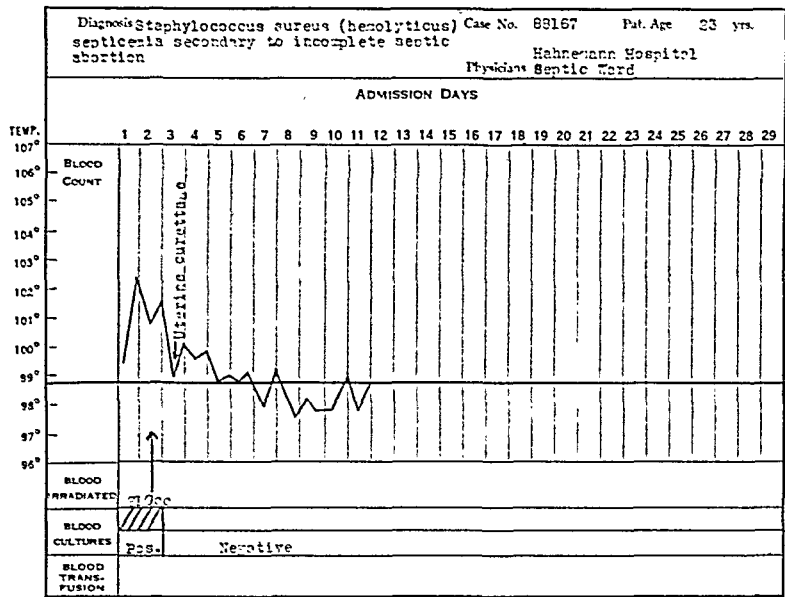


FIG. 5. (Group 2.) Case IV. This patient received ultraviolet blood irradiation therapy plus uterine curettage the following day without knowledge that the blood stream was positive for Staphylococcus aureus in pure culture. Subsequent cultures were negative. The patient convalesced uneventfully.

one can expect from ultraviolet blood irradiation therapy, since one would expect a patient receiving uterine curettage, while bacteria were still present in the blood stream, to undergo a relatively stormy course, and not to be discharged in good condition within a week's time as was this fortunate patient.

CASE VI. No. 83141. This patient was admitted to Hahnemann Hospital January 15, 1943, complaining of severe nose bleed and persistent fever. Physical examination revealed an acute ulcerative rhinitis, and an acute suppurative otitis media, associated with a pregnancy of two months' duration; temperature was 100.2°F., pulse rate 128, respiratory rate 24. Laboratory findings were essentially negative. Her nasal hemorrhage was easily controlled by nasal packing, but the acute otitis media increased in severity in the amount of copious purulent discharge. On January 19th, the patient began to complain of a throbbing sensation in the affected ear. Although her temperature had dropped to a level of 99.0°F., the patient's general condition become extremely tender. Ultraviolet blood irradiation therapy was instituted, and blood culture taken at this time proved to be positive for pure culture of Staphylococcus albus. The patient's toxic symptoms, which had been increasing rapidly, began to subside slowly, but her temperature remained elevated ranging between 98.0° and 100.8°F. Increasing signs of acute mastoiditis became apparent and on February 2nd radical mastoidectomy was performed. Blood culture taken shortly afterward showed the presence of Streptococcus hemolyticus, which was believed to be a transient bacteremia following mastoidectomy. The patient's condition continued to deteriorate slowly despite mastoidectomy, and uterine dilatation and curettage was recommended, since blood cultures taken on February 4th and 5th proved to be sterile. Ultraviolet blood irradiation therapy was repeated followed by uterine dilatation and curettage later the same day. The patient's toxic symptoms began to subside rapidly, and at the end of forty-eight hours she appeared definitely improved for the first time during her hospitalization. Blood culture taken February 8th was sterile. The

phocytes. On the day following admission ultraviolet blood irradiation therapy was given; a blood culture taken just before the blood

3 mm. and 25 mm. at 15 minutes and 45 minutes, respectively. A 500 cc. whole blood transfusion was given immediately. The patient

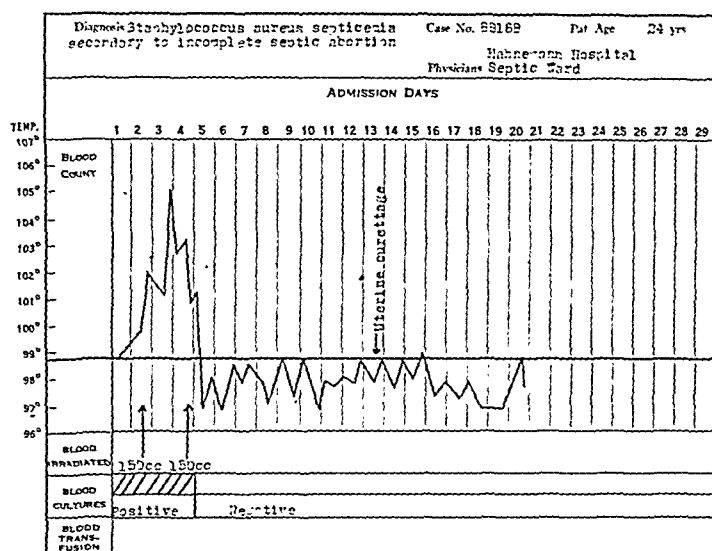


FIG. 4. (Group 2.) Case 111. This patient was admitted with Staphylococcus aureus septicemia secondary to incomplete septic abortion, and failed to show any response following a single blood irradiation but within twenty-four hours after a second blood irradiation her temperature fell to normal and all her toxic symptoms disappeared, convalescence being uneventful.

irradiation later proved to be positive for Staphylococcus aureus hemolyticus. Her condition improved markedly in the first forty-eight hours following blood irradiation, as evidenced by a marked alleviation of all toxic symptoms; the erythrocyte count was now 3,470,000, hemoglobin 12.6 Gm., and leukocyte count 6,800 with 72 per cent polymorphonuclears and 28 per cent lymphocytes. Dilatation and curettage was performed at this time, November 2, 1942, obviously without knowledge that the blood culture would prove to be positive for Staphylococcus aureus. The patient's symptoms disappeared entirely following dilatation and curettage, she convalesced uneventfully, and left the hospital November 9, 1942, in apparently excellent condition, nine days after a single blood irradiation and seven days after dilatation and curettage.

CASE v. No. 82484. The patient was admitted to the septic ward December 23, 1942, with the diagnosis of incomplete septic abortion complicated by severe hemorrhage. Laboratory examination revealed an erythrocyte count of 2,270,000 and a hemoglobin reading of 9 Gm.; sedimentation rate was

suffered a mild transfusion chill, but at the end of forty-eight hours seemed definitely improved. Despite the transfusion, however, the patient's blood picture remained relatively unchanged, the erythrocyte count varying between 2,980,000 and 2,200,000, and the hemoglobin between 9.4 and 8.3 Gm. The patient's temperature rose daily to 99.2°F. This more or less static condition prevailed, but the sedimentation rate began to rise reaching 22 mm. and 34 mm. at 15 minutes and 45 minutes, respectively on January 2, 1943. In view of this it was believed that dilatation and curettage was necessary. Pre-operative ultraviolet blood irradiation therapy was given January 5th; blood culture taken at this time later proved to be positive for Staphylococcus aureus hemolyticus. Dilatation and curettage was performed on the day following blood irradiation, January 6th, at which time no knowledge of the positive blood culture had been obtained. The patient convalesced uneventfully from this point on, and left the hospital January 12, 1943, in apparently excellent condition, seven days after blood irradiation and six days after dilatation and curettage done within twenty-four hours

patient's resistance that recovery was made impossible, even after receiving ultraviolet blood irradiation therapy, a therapy which in Group Two has been found to yield encouraging results in staphylococcemias not complicated by the use of sulfa drugs, which are rather generally known to have little or no effects on most staphylococcemias.

#### SUMMARY

There has been presented a report and analysis of sixteen cases of staphylococcemia given ultraviolet blood irradiation therapy as a method of controlling this type of acute pyogenic infection.

The first seven staphylococcemic individuals treated by ultraviolet blood irradiation therapy failed to respond and died. Six of these seven received intensive sulfa drug therapy, whereas the seventh, whose staphylococcemia arose from a bladder carcinoma and was complicated by atelectasis and empyema at the time of institution of ultraviolet blood irradiation therapy, received only blood irradiation and also died.

The results of ultraviolet blood irradiation therapy in a second group of nine consecutive staphylococcemic individuals given blood irradiation was reported; all nine of these individuals recovered uneventfully; eight of the nine received no sulfa drugs whatsoever, and the ninth, forty-eight hours of sulfathiazole therapy one week before blood culture became positive.

In each of the sixteen cases reported one or more pure cultures of pathogenic strains of either *Staphylococcus aureus* or *Staphylococcus albus* were obtained from blood cultures taken in tryptose phosphate broth.

In fifteen of the sixteen cases there was present a profound toxemia at the time of institution of ultraviolet blood irradiation therapy.

Uterine dilatation and curettage was performed in three individuals of Group Two, the recovery group, while the blood

culture in each of the three individuals was still positive. No untoward effects were observed to follow this radical procedure performed despite the presence of staphylococci in the blood stream.

#### CONCLUSION

1. The apparently paradoxical recovery following ultraviolet blood irradiation therapy in nine consecutive cases of staphylococcemia, after its original reported failure to control acute pyogenic infection in the first seven cases of staphylococcemia we treated, can be attributed to the fact that sulfa drugs were used intensively in six of the seven failures, and that ultraviolet blood irradiation therapy alone was used in the nine individuals recovering from staphylococcemia following ultraviolet blood irradiation therapy.

2. It is our opinion that sulfa drugs are contraindicated in most cases of staphylococcemia.

3. Ultraviolet blood irradiation therapy alone has proved to be a successful method of controlling the acute pyogenic infection in nine consecutive cases of staphylococcemia.

4. The earlier ultraviolet blood irradiation therapy is applied in any acute pyogenic infection, including staphylococcemias, the better are the chances of recovery.

5. The use of sulfa drugs in six cases of staphylococcemia appeared to lower the resistance of each of these patients so severely that the use of ultraviolet blood irradiation therapy, successful when used alone in nine consecutive cases of staphylococcemia, was no longer able to control the staphylococcemia.

6. We must retract our original statement that ultraviolet blood irradiation therapy has little or no effect upon staphylococcemias, and admit that, when used alone, this procedure has been successful in controlling staphylococcemia, at least in nine consecutive cases.



patient convalesced uneventfully, her temperature slowly falling to normal, and she left the hospital in apparently excellent condition February 23, 1943.

toms, such as nausea, vomiting, delirium, fever, general malaise, high pulse and respiratory rates, and mental confusion; (2) a complete disappearance of the in-

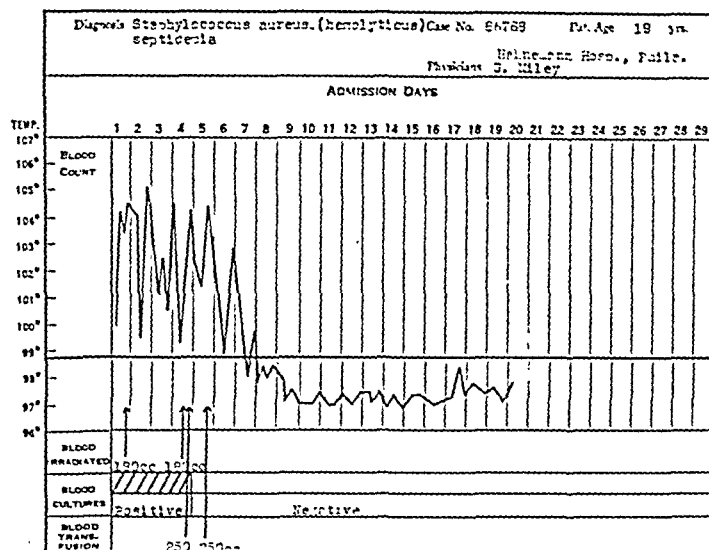


FIG. 6. (Group 2.) Case VIII. This patient, a student nurse, was given ultraviolet blood irradiation therapy initially to control what we believed to be an acute influenzal pneumonitis following measles. It was not until after a second blood irradiation was given that blood culture taken on admission proved positive for *Staphylococcus aureus*, as did a second blood culture taken just before the second blood irradiation. Forty-eight hours after the second blood irradiation the patient's toxic symptoms began to subside, blood cultures became sterile, and her temperature dropped to normal with subsequent uneventful recovery.

#### CLINICAL OBSERVATIONS

The recovery of nine individuals with staphylococcemia receiving ultraviolet blood irradiation therapy alone was certainly the opposite from the results observed in the seven individuals who also were suffering from staphylococcemia but who died despite ultraviolet blood irradiation therapy given after or along with intensive sulfa drug therapy. The chief difference between the two groups receiving ultraviolet blood irradiation therapy is obviously the use of the sulfa drugs in the group that died.

In the recovery group there occurred the same sequence of events already reported to occur in other acute pyogenic infections.<sup>2,3,7,11</sup> These are briefly (1) a marked detoxification effect manifested by a pronounced subsidence of toxic symp-

vading bacterial organism; (3) grossly discernible peripheral vasodilation, and (4) a complete absence of deleterious effects.

Apparently the use of sulfa drugs so greatly lowered the resistance of the individuals in Group One that ultraviolet blood irradiation therapy was no longer able to be of any benefit to these patients. This may possibly be due to the fact that once sulfa drugs fail to control an infection one encounters all the ill effects of a toxic drug, producing generalized tissue anoxia, superimposed upon the toxic products of bacterial growth and decomposition. In any event, it is our opinion that the use of the sulfa drugs in the cases of staphylococcemias seen by us has had no beneficial effect whatsoever, but on the contrary has so seriously lowered the individual

# SYNERGISTIC MIXTURE OF AZOCHLORAMID, UREA AND SULFANILAMIDE\*

## EXPERIMENTAL AND CLINICAL STUDY

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CHEMOTHERAPEUTIC agents are known to depend to a great extent upon the natural cellular and humoral defenses of the infected host for their ultimate effects, hence the value of the topical administration of sulfonamides has been questioned by some. From the work of Fournau, Trefouël, Trefouël, Nitti, and Bovet,<sup>1</sup> Colebrook,<sup>2</sup> and others, we know, however, that sulfonamides act directly on bacteria by inhibiting their growth. For this reason, and also because the cellular defense, i.e., phagocytosis, is known to participate actively in the cleaning of wound infections, topical application of sulfonamides seems to be justified. The results obtained in the prevention of wound infection have been remarkably good. The effects observed when grossly infected wounds were treated with sulfonamides were not as favorable. This is usually attributed to the presence of large amounts of sulfonamide inhibitors in wounds containing pus and tissue débris (Lockwood<sup>3</sup>). *In vitro* experiments have shown that the concentration of sulfonamide necessary to inhibit growth depends on the size of inoculum, consequently sulfonamides are rather ineffective when used on wounds containing pockets of pus which harbor a large number of bacteria.

The problem of decreasing the size of inoculum and destroying the sulfonamide inhibitors has attracted the interest of many investigators recently. In an attempt to analyze the good results which Goldberger<sup>4</sup> obtained using a combination

of azochloramid, a chloramine disinfectant, with sulfanilamide on infected wounds, Neter,<sup>5,6</sup> and Schmelkes and Wyss<sup>7</sup> investigated the effect of this combination *in vitro*. They found that the addition of small amounts of azochloramid, which alone failed to prevent growth of *Bacillus coli*, to a solution of sulfanilamide which also was ineffective in inhibiting the growth of bacteria resulted in a mixture which prevented growth completely. The effect appeared to be much more than additive. Schmelkes and Wyss attributed this effect of azochloramid to its destructive action on p-aminobenzoic acid, the most notorious sulfonamide inhibitor. The destruction of p-aminobenzoic acid may be due to its oxidation or chlorination by azochloramid. In this connection it is of interest that recently Wyss, Rubin, and Strandkov<sup>8</sup> have shown that some chlorine derivatives of p-aminobenzoic acid are not only inactive as growth promoters but are actually potent growth inhibitors. Azochloramid also reduces the extent of contamination, that is, the number of bacteria present in the wound. The possibility that azochloramid oxidizes some of the sulfonamides and produces small amounts of a highly active agent cannot be entirely disregarded.

Recently, Clark<sup>9,10</sup> and his co-workers have demonstrated another method of sensitization of bacteria to sulfonamides. They found that in synthetic media 1.25 to 1.75 per cent urea enhances the action of sulfonamides considerably and also that organisms resistant to sulfonamide

\* From the Department of Surgery, New York Hospital and Cornell University Medical College, New York.

7. Finally, the use of ultraviolet blood irradiation therapy is preferable to the use of sulfa drugs in the treatment of staphylococcemias.

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was carried out on the opposite side using the same amount of suture material, but no drug was placed into either the muscle or subcutaneous tissue.

At the close of each operation as much powder was insufflated into one eye as was necessary to fill the socket space and cover the globe.

Subsequently, contralateral sides were biopsied from two to ten days following implantation and the tissue examined microscopically. No difference was noted in the treated and untreated side. In none of the animals used was there evidence of the presence of drug in their eyes, nor was there any suggestion of inflammatory reaction after twenty-four hours.

In a second group of experiments, ten full grown rats (250 Gm.) were anesthetized and an incision of approximately 1 to 2 cm. was made in the midline, opening into the peritoneal cavity. Approximately 50 mg. of the powder was applied in this area, and the wound was closed with silk. Subsequently, two animals were sacrificed at each one, two, four, seven and fourteen-day interval and the viscera examined microscopically. Sections showed no evidence of parenchymal damage, although in the fourteen-day rats there was some fibroplasia in the mesentery and splenic capsule.

*Clinical Use.* Due to the absence of any untoward effects attributable to the combination when used on fresh wounds and on sensitive mucous membranes it seemed justifiable to use it in a small series of cases of localized pyogenic infections in humans.

Work was conducted in an active surgical out-patient department using ambulatory patients. Prior to the use of this combination sulfanilamide buffered with calcium carbonate was used in granulating wounds. Good results have been reported recently by Scott<sup>19</sup> in primary closure following excision of potentially contaminated pilonidal sinuses on the use of this preparation. It was apparent, however,

after ten patients with infected lesions had been treated that sulfanilamide, even though buffered, was of little value in cleaning up these wounds and promoting healing. This was presumably due to the presence of pus and necrotic debris containing sulfonamide inhibitors. In these wounds, sulfanilamide appeared to retard rather than accelerate the ultimate healing, even though the actual hydrogen ion concentration of the wound itself could be kept between 6.5 and 7.8.\*

In a second series of twenty-five cases the combination described above containing urea and azochloramid was used as the only form of definitive therapy. The powder was applied to infected open lesions and patients were redressed at unusually infrequent intervals. The lesions were generally of the chronic type of infected wounds which often require clinic treatment for weeks and months. The patients were for the most part unimaginative and abhorred any form of home therapy, relying on occasional clinic visits for all treatment.

In order to save space treatment and results are given in the Table on page 326 in an abbreviated form (Table 1).

It is realized that the series is neither sufficiently homogenous nor sufficiently large to allow statistical comparison with a similar series treated with other methods of therapy. The results given in the chart indicate, however, that the combination is worthy of serious consideration and it may prove upon subsequent investigation to be a valuable aid in the treatment of infected lesions. Recently Long<sup>20</sup> and Crile<sup>21</sup> have reported on good results obtained by the simultaneous application of azochloramid and sulfanilamide. Our small series with a preparation based on the same rationale appears to corroborate their results.

It was attempted to obtain the impartial opinion of some physicians, whose comments should be fairly reliable because of

\* Hydrogen ion concentration determinations were carried out with a small glass electrode.

become sensitive to this drug in the presence of urea. Holder and MacKay<sup>11,12</sup> among others have used urea and sulfonamide combinations clinically with good results.

Another interesting finding which is of great importance in the practical application of sulfonamides is the enhancing effect that increasing of the hydrogen ion concentration has on the antibacterial action of sulfonamides. The magnitude of this effect and the hydrogen ion concentration range in which it can be observed varies with different sulfonamides. It increases as the acidity (dissociation constant) of the sulfonamide decreases. Thus among the most important sulfonamides it is the greatest with sulfanilamide,<sup>13,14,15</sup> At a hydrogen ion concentration of 9, which is close to the highest concentration with which tissue repair is compatible, sulfanilamide is as active as sulfathiazole or sulfadiazine if equal concentrations are compared. Sulfanilamide is, however, very much more soluble and in saturated solutions it at least equals the activity of the above mentioned sulfonamides even at a hydrogen ion concentration of about 8.

The consequent advantages to be incurred by the application of the described findings to local chemotherapy are obvious. Both compounds, azochloramid and urea, which enhance the activity of sulfonamides *in vitro* have been used extensively in the treatment of wounds as an aid to surgery. Azochloramid has been shown recently by Welch, Slocum and Hunter,<sup>16</sup> Salle, McOmie, Shechmeister, and Foord,<sup>17</sup> Hirsch and Novak,<sup>18</sup> to be one of the disinfectants with a very small toxicity index.

In view of the sound rationale and the encouraging results of a few sporadic trials with a 10 per cent suspension of sulfanilamide in a solution of azochloramid in triacetin (1:500) in the course of the past two years, it was decided to test a preparation in which sulfonamide was combined with a small amount of azochloramid, urea, and a buffer mixture. In addition

to these constituents a small amount of wetting agent was also added to the preparation\* to insure even distribution and better penetration of the active ingredients. This product was prepared in the form of a stable powder suitable for application to wounds and which had a particle size between 40 and 80 mesh. The composition of the preparation is as follows: 9.5 per cent urea, 5.0 per cent disodium phosphate, 75 per cent sulfanilamide, 10 per cent calcium carbonate, 0.1 per cent azochloramid, 0.2 per cent granulating agent, 0.2 per cent sodium tetradecyl sulfate.

Control powders used in this study were: Buffered sulfanilamide containing 90 per cent sulfanilamide and 10 per cent calcium carbonate, and a powder which contained the azochloramid and sulfanilamide but did not contain either calcium carbonate or urea.

*Experimental Use.* Before application of this powder to human lesions, animal experiments were conducted to test the local toxic effects of the drug.

The following experiments were carried out: Male rabbits of approximately 3,200 Gm. weight were used. The skin of the back was shaved and prepared for operation by the application of iodine and alcohol, and the area draped with sterile towels. An incision approximately 2.5 cm. in length was made paravertebrally at a site about one inch below the twelfth rib. In succession, the superficial and deep fascia were incised exposing the sheath of the lumbar group of muscles. This fascial covering was then opened and the muscle fibers split bluntly so as to form a cavity, into which was placed from 1 to 2 Gm. of the composite powder. The wound was then closed in layers with interrupted silk sutures, another 1 Gm. of powder being implanted directly under the skin. Exactly the same procedure

\* Acknowledgement is due to the Research Department of Wallace & Tiernan Products, Inc., Belleville, New Jersey, for generous supply of the combinations of Azochloramid and sulfanilamide (AZOCHLORASUL).

the generally healthy skepticism with which all "new drugs" are treated by them. Their notes on the patients' charts can be summarized as follows:

I. It was universally agreed that wounds "cleaned up quickly." By this it was meant that healthy, clean granulations were obtained in a shorter period of time than in cases in which occasional dakinization, bland ointment, or pure sulfonamide powder or paste was used.

II. The interval between clinic visits was long, the number fewer and the time devoted to treatment was minimal.

III. There was no evidence of tissue injury, nor was there caking of the powder in the wounds. No subjective complaints were recorded. Sulfanilamide levels taken in a few instances were reported from a trace to 1 mg. per cent.

A few patients have been treated so far with a control powder without buffer and urea. This powder also appeared to produce satisfactory results suggesting that the essential merit of the combination is that of the simultaneous action of azochloramid and sulfanilamide.

#### SUMMARY

A wound dusting powder having as its main constituents sulfanilamide, azochloramid, urea, and buffer has been investigated. It exhibited no apparent tissue toxicity in experimental animals and in a small series of clinical cases. Results obtained in twenty-five cases of infected lesions showed that the preparation has definite merits.

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TABLE I

Patient	Age	Type of Lesion	Healing Time Days	Interval of Treatment	Remarks and Previous Treatment	Cultural Findings
H. N.	24	Avulsion of skin, 32 cm.	10	q. 3 d.	Primary closure, healed	
G. M.	2	Infected 2nd degree burn	6	q. 2 d.	Debridement	
L. M.	44	Carbuncle, 1 × 2 cm.	10	q. day, 2 d.	Incision and drainage	Staphylococcus aureus hemolyticus
J. L.	48	Infection due to artery defect	64	q. 3-4 d.	With involvement of ischial bone	
F. J.	32	Infection around tube graft	16	q. 2 d.	Tube graft took	Staphylococcus aureus hemolyticus and non-hemolyticus
G. H.	60	Paronychia 2nd toe with ulcer	15	q. 3-4 d.	Poor peripheral circulation due to arteriosclerosis	Staphylococcus aureus hemolyticus
P. H.	40	Trophic ulcer over tube	12	q. 3-4 d.		
H. H.	48	Abscess of middle finger	38	q. 1 day, 2 d.	Incision and drainage twice	Staphylococcus aureus hemolyticus
F. D.	20	Axillary abscess, 2 × 2 cm.	12	q. d.	Incision and drainage	Staphylococcus aureus hemolyticus
I. D.	32	Traumatic amputation of finger, failure of free graft, infection	60	q. 2-3-4 d.	Primary closure with graft, no tube infection	Staphylococcus albus, nonhemolyticus; diptheroid bacillus
C. D.	46	Diabetic gangrene of foot	120	q. 3-4 d.	Diabetes controlled, no amputation necessary	
J. D.	10	Osteomyelitis	40	q. 3-4 d.		
A. C.	60	Old 2nd degree burn	28	q. 5 d.		Staphylococcus aureus hemolyticus
T. C.	48	Axillary abscess	60	q. 2-3 d.	Incision and drainage had repeated treatment pockets	Staphylococcus aureus hemolyticus
M. B.	13	Felon	48	q. 2 d.	Incision and drainage	
K. A.	30	Infection of finger	26	q. 2 d.	Followed excision of xanthoma	
G. P.	32	Infected sebaceous cyst	10	q. 2-3 d.	Incision and drainage	
M. O.	82	Varicose ulcer, 4 cm.	92	q. 2-5 d.	Failure of improvement with Unna boot, Ace bandage	
H. R.	10	Avulsion of skin of finger, 1 cm.	5	q. 2 d.	Debridement	Staphylococcus aureus hemolyticus
S. R.	51	Carbuncle of neck		q. d.	Incision and drainage, patient lost to clinic	
F. S.	16	Infected pilonidal sinus	10	q. 4 d.	Improved but not healed	
W. W.	52	Varicose ulcer, 2.5 cm.	38	q. 4 d.	Nearly healed boot failed to improve	
M. N.	13	Abscess of arm, 5 cm.	15	q. 3 d.	Incision and drainage	Staphylococcus aureus hemolyticus
M. F.	66	Varicose ulcer	10	q. 2 d.	Ulcer not healed but clean for boot	Staphylococcus aureus hemolyticus
M. M.	70	Varicose ulcer	16	q. 3 d.	Ulcer not healed but clean for boot	

logical factors. Wagoner and Cohn, in their definitive review of the literature, mention heredity as another possibility.

Early authors were convinced that trauma from the outside is the direct causative agent in the formation of loose bodies. Both Kragelund and Paget, however, held that it was impossible for a mere blow to detach a cartilaginous fragment, but the sequestrum could result from trauma followed by a chronic inflammatory process. Axhausen postulated "that as a result of impaction from the opposing articular surface, the blood vessels to the part are damaged, either with or without partial fracture, according to the severity of the violence. This leads to necrosis of the area supplied by the damaged vessels and as a result there forms a zone of absorption resulting in gradual separation and eventual extrusion of the dead portion of the articular surface into the joint."

Other theories include the possibilities of a subchondral impression fracture, a pull of the posterior cruciate ligament (experimentally proved impossible), an impaction of the tibial spine on the intercondyloid ridge, or tangential and rotating forces acting on the convex condylar surfaces and fissures and partially or completely detaching portions of the articular ends.

Of the non-traumatic theories, that of embolism is most frequently presented. According to Conway, "... first, mycotic-embolic closure of an epiphyseal artery may lead rapidly to epiphyseal necrosis; secondly, ... the bacteria deposited may be vanquished by the body so that an infection does not take place and the necrosis remains aseptic. Thirdly, the joint bodies may develop *in situ*; therefore, from the aseptic epiphyseal necrosis by a process of demarcation. Although the epiphyseal arteries are not terminal arteries in the anatomical sense, inasmuch as fine lateral connections may be demonstrated, still the anatomical findings do not prove that the functional capacity of these fine connections is sufficient to insure nutrition

of the epiphyseal region following closure of the chief arterial trunk."

Knaggs believes that the lesion is primarily a periostitis due to a very mild type of micro-organic infection, probably staphylococcic. Since this infection has only a feeble virulence, the invasion of the surface of the bone is limited, failing to penetrate the surface of the compact bone deeply. Compression of the vessels and interference with the blood supply of the compact bone in its deeper parts is caused by granulation tissues developing under the periosteum and in the Haversian canals of the superficial layers. The nutrient canal must also be invaded before necrosis will take place and curtail the supply of blood to the medulla, thus rendering the circulation within the bone unequal to the demands.

Kappis offers the explanation of a constitutional disturbance involving the bone, presupposing a congenital excessive brittleness in the epiphyseal bone, in cases in which severe injury was absent.

The consensus is that the traumatic theories are the more reasonable. The condition usually occurs in age groups more often subjected to trauma. Another factor is the absolute lack of suppuration. No gross or microscopic inflammatory changes are to be observed in or about the lesion. Conway reports that cultures prepared from excised tissue, taken from the synovial membrane lining the joint as well as from the site of the lesion, invariably display no signs of growth. Nor has bacteria ever been discovered in specimens of the joint fluid.

Even though a history of trauma is not the rule in most reports, there is still the possibility that a fracture of the articular surface may have occurred with little or no pain, since the articular cartilage does not contain a nerve supply and little sensation is felt in the cancellous bone underneath.

Conway concludes with this statement: "The most logical explanation seems to be that which allows for a preliminary



# OSTEOCHONDRITIS DISSECANS

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THE term, *osteocondritis dissecans*, coined by König in 1905, refers to an osseocartilaginous lesion of debatable etiology, characterized by a partial or complete demarcation of a segment of articular cartilage and subchondral bone, with or without ultimate detachment and extrusion into the joint. The condition has been reported in the knee, elbow, hip, ankle, shoulder and metatarsophalangeal joints, as well as in the patella, the carpal scaphoid or carpal semilunar, the tibia, the head of the radius, the os calcis, the acetabulum and the lumbar vertebrae.

According to Liebman and Iseman, there are three stages in which the osteochondritic focus may be found. When retained in the original bone cavity, the articular surface is convex and covered with hyaline cartilage, whereas the deep surface will be rough and covered with fibrocartilage. When loose in the joint, the bodies tend to become rounded and may grow by accretion of new bone. The hyaline layer usually changes into fibrocartilage and the separated body may break up into numerous smaller fragments. Sometimes a free body becomes attached to synovial villi, thus forming a pedicle. When this occurs, rapid proliferation and enlargement of bone and cartilage take place.

The microscopic findings of excised specimens have been reported either as chronic inflammation or aseptic necrosis. However, inflammatory changes have not been demonstrated by the majority of

investigators. The degree of necrosis varies inversely with the degree of detachment, according to the above classification. The defect in the bone may remain, or it may fill in slowly after complete separation has taken place.

The following table illustrates the characteristic locations of the condition as reported in the various bones and joints:

Site	Characteristic Location
Knee.....	The lateral aspect of the medial condyle of the femur
Elbow.....	The capitellar epiphysis of the humerus
Hip.....	The superior and lateral aspect of the articular surface of the femoral head
Ankle.....	The superior and medial angle of the articular surface of the astragalus
Shoulder.....	The articular surface of the head of the humerus
Metatarsal bone...	The articular and distal end

Only isolated cases have been reported in the other bones mentioned above. The condition has also been reported bilaterally.

## INCIDENCE

Osteochondritis dissecans is mainly a disease affecting young adults, with a marked predominance in males. The occurrence is probably more frequent than is normally suspected. Approximately 85 per cent of reported cases involve the knee joint.

## ETIOLOGY

This condition has been divided broadly into traumatic and non-traumatic etio-

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helpful in cases in which the condition is suspected but cannot be visualized by conventional radiography.

#### DIFFERENTIAL DIAGNOSIS

Free bodies within the joints other than osteochondritis dissecans are grouped under the common heading of corpora libera articularum, or "joint mice." Wagoner and Cohn group them as follows:

1. Free bodies of traumatic origin may arise in otherwise normal joints. Cartilaginous or bony "mice" occasionally follow severe trauma to the bones comprising a joint. Pieces of normal cartilage or bone may be torn loose and appear free within the joint. An example is found in fractures of the semilunar cartilages. Severe trauma to the joints is frequently followed by periarticular formation of bone.

2. Free bodies may appear in joints that are the site of arthritis deformans. These bodies arise by the traumatic or necrotic freeing of articular cartilaginous plaques, hypertrophic bony spurs, bony joint papillae, metaplastic cartilage or hypertrophic fibrinous synovial villi. These bodies usually are present in large numbers, varying greatly in size, and frequently presenting a mulberry-like surface.

3. The polypoid bodies present in the hypertrophic type of arthropathic tabétique (incorrectly known as Charcot's joint) present the same general etiology noted for free bodies appearing in the joints in arthritis deformans.

4. Masses of uric acid salts of various sizes, usually sodium biurate, are frequently found free within gouty joints.

5. Osteomyelitis sequestrums occasionally appear within a joint.

6. Parts of tumors of the capsule in chondromatosis of a joint sometimes are found free within a joint.

7. Fibrous or lipomatous joint papillae (lipoma arborescens) occasionally become loosened and form free bodies in the joints.

8. Parts of hypertrophic synovial villi

following a synovitis may be severed from their base by trauma or necrosis and appear within the joint as free bodies. When these villi or papillae contain cartilaginous foci or "rests," the process becomes known as "synovitis prolifera cartilaginea."

9. Corpora oryzoida (rice bodies) arise as a result of tuberculous involvement of the structures adjacent to a joint. They are numerous, and their structures are those of fibrinoid lamellated masses.

10. Following hemorrhage into, or inflammation of, a joint, masses of fibrin may result and lay free within the joint.

11. Foreign bodies from external sources may become lodged within the joint.

Osteochondritis dissecans is differentiated from tuberculosis of the knee by the following criteria, according to Liebman and Iseman: (1) Tuberculosis tends to have severer symptoms. (2) The tuberculous joint has a generally obscured appearance on the roentgenogram, unlike that of a true osteochondritis dissecans. (3) There is usually a much greater degree of atrophy in tuberculosis. (4) The location of the process is different. In osteochondritis dissecans the areas of the articular surface which have the most contact are involved, while in tuberculosis there is early destruction of areas in which there is little or no contact. (5) Sequestration in tuberculosis shows a sequestrum of increased density which preserves its line of articular cortex, while the surrounding bone is relatively atrophic and the articular cortex indefinite or destroyed. In osteochondritis dissecans, the articular cortex is intact except in the sequestered area, and the latter is of a similar or less degree of density than the adjacent bone.

In the case of a torn medial meniscus, the history and lack of characteristic roentgenographic changes should eliminate osteochondritis dissecans.

Hemophilic joints may at times show multiple, punched-out areas, usually involving more than one joint. The clinical course of acute febrile episodes following trauma, multiplicity of the lesions and

trauma to a non-sensitive articular surface with subsequent injury to a functional end-artery. Following the vessel damage and thrombosis, a localized area of necrosis results with sequestration of a fragment from the articular surface."

#### SYMPTOMATOLOGY

The symptoms referable to the knee depend upon the degree of pathological change present and whether or not the osteochondritic focus is attached or free in the joint. In the early stages there may be merely indefinite symptoms with various degrees of dysfunction. Some pain is usually present following excessive movement or exercise. The knee itself becomes weak or unstable, and tenderness may be observed over the joint area.

In a clinical study of twenty-four cases, Don King divided them into three well defined groups, as follows: (1) Patients whose symptoms were markedly severe shortly following slight trauma, but without a previous history of disability; (2) asymptomatic cases, discovered by routine examinations of supposedly normal knees, x-rays taken mainly for comparative purposes; these were designated as "slumbering" cases; (3) cases presenting a history of definite trauma or of a "chronically troublesome knee joint" for several years, with recurrent sudden "lockings" of the joint upon extension. In some cases the loose body could even be palpated. In every case, though, the x-ray findings were the decisive factor in establishing the diagnosis. This group embraced the majority of cases in King's report.

Fluid in the joint is not an uncommon finding in long standing cases with synovial membrane involvement.

In general, pain, weakness and disturbance of function are the most common findings in osteochondritis dissecans involving joints other than the knee. Of particular importance in the early cases is pain brought on after prolonged standing, walking or exercising. Wasting of soft tissue is a later sign.

#### RADIOLOGICAL APPEARANCES

Burr describes it as follows: "The lesion is seen as a sharply defined shallow depression, irregularly ovoid in outline, containing in its centre a button of bone, the density of which may vary from that of a fully separated sequestrum to one differing so slightly from the normal bone about it as to escape entirely any but the most careful search. Various degrees of development may be observed, from those cases which are examined during the early stage of the disease to those in which the process is fully established. In the early stage the dissecting line may fade out at one border of the lesion, leaving a hinge to connect the separating fragment of bone and cartilage to the parent bone. In these cases there is practically no change in the density of the bone lying in the loosened fragment. When the condition is more advanced and separation is complete, so that the fragment simply lies unattached in the pocket in the femur, the bone may have the density of a sequestrum and is then most readily detected in the roentgen film. At a later stage the fragment becomes separated and lies as a loose body, first in the intercondylar notch of the knee and then in any situation to which it is forced by movement. A film made at this time will show the pond-like depression in the articular surface and a loose body somewhere in the joint."

In long standing cases, with the osteochondritic focus extruded into the joint cavity, a slight osteoporotic area may be visualized in the femoral condyle, localizing the source of the joint body.

The anteroposterior projection is the most commonly employed, but excellent visualization of the lesion may also be obtained in the lateral view with separation of the condyles to avoid overlapping. Stereoscopic films and "coned" views are of additional value in identification of the lesion.

Serial study, taken at monthly intervals, is especially valuable to follow the development of the condition. Tomography is

one. Nine cases were presented with no report of treatment, and the remaining seven were treated surgically: arthrotomy

gested. Serial stereoscopic x-ray studies following immobilization, while the patient is on limited activity, should prove of



FIG. 1. Case 1. Anteroposterior view of the left knee. Note the calcified loose body in the joint and the area of lessened density in the lateral portion of the medial condyle of the femur representing the osteochondritic bed.



FIG. 2. Case 11. Anteroposterior view of the left knee. The osteochondritic focus is clearly demarcated and lying in relation to lateral portion of the medial femoral condyle which is the characteristic location of the osteochondritic bed.

and removal of the joint body, five cases; fusion, one case; and an arthroplasty, one case. In general, the operative results were not as successful as the conservatively treated patients. However, several patients had shown evidence of osteoarthritis preoperatively.

According to Freund, physical therapy may temporarily relieve symptoms, but it will have no lasting effect. Surgical treatment is the only consideration for advanced and extensive epiphysioneclerosis.

From the above survey then it is evident that surgery is a definite indication in patients with loose bodies in the joints. In patients in whom the osteochondritic focus is not detached from its bed, conservative therapy with a short period of immobilization and observation is sug-

great service in determining the progress of the lesion. If the x-ray visualization suggests the imminence of loose body formation, surgery is indicated. In the "slumbering type," in which the lesion is discovered merely as an incidental finding and no symptoms exist, routine observation should be pursued.

#### CASE REPORTS

**CASE 1.** The patient, aged twenty-nine, entered the Station Hospital, on December 28, 1942, complaining of swelling and stiffness in the left knee. Examination revealed a moderate degree of diffuse swelling, but no tenderness was noted. The patient demonstrated a full range of painless motion with marked crepitation. On auscultation a loud, grating sound could be heard between 130 and 90 degrees.

evidence of the disease elsewhere should serve to differentiate the two conditions.

The defects of skeletal tophi in gout are uncommon in large joints and they are rarely centrally located. The age incidence, too, is distinctly different.

#### TREATMENT

In osteochondritis dissecans of the knee, ankle or elbow joint, treatment is either conservative or surgical. Kilfoley reported almost 100 per cent restoration of function in most cases in which loose bodies were excised. He suggested though that the patient be warned of the possibility of a recurrence.

Radical operations resulted satisfactorily for 88 per cent of the cases reviewed by King. He advised conservative treatment, however, for "slumbering" cases, since spontaneous healing was observed in such cases. Cases of long duration with arthritic involvement and many free bodies, according to King, are not cured by operation, for many of the symptoms are due to the accompanying synovitis.

On the other hand, Fairbank states that in the presence of symptoms, the joint should always be explored. An attempt should also be made to determine whether the overlying cartilage is movable or not. If it is, excision of the bone and cartilage is advised. If the cartilage does not move over the bone, the determining factor is the exact condition of the cartilage within the circumference of the lesion. If the cartilage is fractured, but an unbroken portion is holding the fragment in place, the fragment should be removed. Fairbanks does not advise curetting or otherwise treating the floor, since there is no object in making the crater deeper. The margins of the cartilage, and not the bone, are involved in the filling in process. In all cases, though, the semilunar cartilage should be examined for possible lesions.

Arthrotomy with the removal of the loose fragments is the only procedure, according to Conway. If done soon after

the diagnosis, synovitis and traumatic arthritis will have less chance to develop.

Burr claims, too, that conservative treatment is useless in any case, as healing without surgery is rare. Concerning curetting the cavity at operation, Burr believes that even though differences in opinion do exist, complete restoration of the involved joint in a period of eight to ten weeks with no further symptoms is the usual result in either method. Immediate surgery is suggested in cases with definite symptoms, as the condition may involve other parts of the joint, due to hemorrhages or mechanical interference.

Liebman and Iseman, on the other hand, reported a case in which a satisfactory result was obtained by immobilization alone. However, no loose body was observed in this case.

Mensor and Melody suggest arthrotomy, removal of loose fragments, no immobilization but rehabilitation therapy, diathermy, massage and graded exercises. Reporting a case of osteochondritis dissecans of the ankle joint, they state that immobilization was not applied after the loose body was removed and the surgical wound healed *per primam*.

Describing a case in the elbow joint, Murphy recommended immobilization for seven to ten days following surgery, thereby giving the joint complete rest for the first few days of healing.

Since sequestration is more complete in the ankle, elbow or knee joints, arthrotomies are relatively simple in these regions. The hip joint, however, presents operative and technical difficulties in exploration and in location of the fragments. King and Richards discuss at length the advisability of removing the sequestered fragment. Gold reports that of the twenty-two cases of osteochondritis dissecans of the hip mentioned in the literature, conservative treatment was carried out in six, with follow-up periods varying from five months to eight years. Reconstruction and union of the fragment to the femoral head occurred in all but

ally subsided over a period of three months. In May, 1942, the knee began to lock and the loose body was first felt on the lateral aspect of the joint. Locking became more frequent thereafter, often occurring several times a day. The knee would frequently give way suddenly, causing him to fall several times while marching.

An x-ray taken on January 7, 1943 visualized a spherical calcification, approximately 1½ cm. in diameter, lying in relation to the lateral portion of the articular surface of the medial femoral condyle, representing an osteochondritis dissecans. Arthritic changes were noted, involving the tibial spines and the articular surfaces of the proximal end of the tibia. A second calcification of similar size was seen lying in relation to the medial condyle of the femur on a plane approximately 2 cm. above the knee joint interspace.

An arthrotomy of the left knee was performed on January 30, 1943. The exposed joint revealed a moderate degree of osteoarthritic change, evidenced by lipping at the edges of the joint surfaces. A deep crater, measuring 1 by 1½ cm. in diameter, was observed on the inferior surface of the internal condyle, near the attachment of the posterior cruciate ligament. A loose body, lodged within the crater, was lifted out with a forceps, disclosing a rough, purplish lining in the crevice. This surface was freshened by superficial curettage. Further exploration of the joint revealed another loose body lying in the suprapatellar pouch. This button of bone was smooth, hard and white, 1 cm. in diameter.

The postoperative course was uneventful. The patient was discharged from the hospital on March 12, 1943. In a recent interview, he said that neither locking nor buckling had recurred since the operation, but the joint was still moderately painful and weak on weight bearing. A slight limp persisted.

**CASE III.** This patient, aged nineteen, was admitted to the Station Hospital on November 24, 1942, with a complaint of pain in the left knee. Neither swelling nor limitation of motion were observed on examination. The joint was stable, but a small area of tenderness over the anterior attachment of the internal semilunar cartilage was noted. The patient walked with a slight limp.

Nine days of bed rest relieved the symptoms, so the patient was returned to duty. However, the marching and calisthenic routine caused

a recurrence of a full, aching pain. He was readmitted to the hospital on January 28, 1943. The onset of the symptoms followed an



FIG. 5. Case v. Anteroposterior view taken pre-operatively. Note the button of bone lying in the femoral bed.

injury on July 23, 1942, when he struck his knee against the steel shaft of an armature while working at a power plant. The knee became swollen and stiff and the pain incurred persisted. A series of heat treatments were given but no relief occurred. Following enlistment in the army on October 30, 1942, the symptoms were aggravated by the ordinary routine of basic training.

An area of mottled density in the lateral portion of the medial condyle of the femur, near its articular surface, was revealed by the roentgenogram taken January 12, 1943. A diagnosis of osteochondritis dissecans was made.

An arthrotomy of the left knee was performed on February 3, 1943. When the joint was exposed, a small amount of clear, straw-colored fluid was encountered. An area measuring 2 by 2½ cm., the surface of which was paler than normal and slightly raised above the surrounding surface, was seen on the lateral aspect of the internal condyle near the attachment of the posterior cruciate ligament. This area was outlined with the point of a scalpel, the incision

The patient could recall no definite history of trauma to the knee, but he began to experience intermittent pain at the joint some

also noted, apparently the result of trauma caused by the loose body. The loose body was excised, but no attempt was made to resect



FIG. 3. Case III. Anteroposterior view of the right knee. Note the mottled lessened density in the medial femoral condyle.



FIG. 4. Case IV. Anteroposterior view of the left knee. The typical lesion and its location are easily identified.

fifteen years before. Occasional locking or buckling would occur, especially following activity in strenuous sports. However, the symptoms were never severe enough to warrant medical attention. The marching and calisthenic routine experienced in the army aggravated the symptoms sufficiently to necessitate hospitalization.

X-ray examination made on December 27, 1942 disclosed a mottled calcific density, approximately  $2\frac{1}{4}$  cm. in diameter, lying in the anterior and lateral portion of the left knee joint, characteristic of an osteochondritic loose body. An area of lessened density was observed in the lateral portion of the medial condyle of the femur, probably the site of the osteochondritis dissecans.

An arthrotomy of the left knee was performed on January 5, 1943. A hard, white, mulberry-shaped loose body, measuring 1 by  $1\frac{5}{10}$  cm. was discovered lying in the intercondyloid fossa. A small, depressed, stellate scar was observed on the lateral aspect of the medial condyle. Several shallow grooves on the articular surfaces of the condyles were

the area of osteochondritis, as it appeared healed.

The patient made an uneventful recovery and was able to return to duty on January 29, 1943. A recent interview disclosed the fact that he is now able to continue his marching and calisthenic routine without pain, locking or buckling of the knee. Swelling has never recurred.

CASE II. The patient, aged forty-two, entered the Station Hospital on January 10, 1942, with a complaint of frequent locking of the left knee. Examination revealed a full range of motion, no tenderness or swelling, but considerable crepitation. On repeated examination, a pea-sized loose body could be palpated at the joint line, at times on the lateral side, and at other times on the medial side of the joint.

The patient presented a history of "rheumatism" in the knee for the past twenty years, characterized by stiffness and occasional mild swelling. On February 7, 1942, he stepped on a corn cob and snapped the left knee into hyperextension, causing severe pain, limitation of motion and swelling. These symptoms gradu-

3. The value of x-ray examinations, including stereoscopic and serial studies, was discussed.

4. Five cases were reported with x-ray illustrations and operative findings included.

5. Careful observation of these cases will be continued to determine their fitness for full duty or limited service status.

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being carried through the cartilage. The incised cartilage was not attached to bone and was easily lifted out with a forceps, thereby exposing a crater in the bone with a grayish-purple surface which was freshened with a curette. No other changes were noted in the joint.

The postoperative course was uneventful, except for a rather marked effusion during the first two weeks. The patient was discharged from the hospital on March 25, 1943, with no complaints.

**CASE IV.** The patient, aged twenty-three, was admitted to the Station Hospital on January 25, 1943, complaining of pain and stiffness in the left knee. Examination revealed a knee which appeared normal, with no swelling or tenderness and a full range of painless motion. However, a slight limp accompanied walking.

The patient could recall no history of trauma. The onset of symptoms occurred in December, 1940, at which time he began to limp, because of severe pain on weight bearing. After several weeks of this, the symptoms cleared up spontaneously, except for mild pain while walking.

Following induction into the army in November, 1942, the basic training routine increased the pain sufficiently to cause a limp and occasional stiffness in the knee joint. However, neither locking nor buckling ever took place.

X-ray examination on January 5, 1943, revealed an oval area of mottled density in the lateral articular portion of the medial condyle of the femur, characteristic of an osteochondritis dissecans. No loose bodies were noted in the joint at this time.

An arthrotomy of the left knee was performed on January 28, 1943. Inspection of the joint showed that the joint cartilage was pale and dimpled over an area of  $1\frac{1}{2}$  cm. in diameter on the lateral aspect of the internal condyle near the attachment of the posterior cruciate ligament. A scalpel was used to outline the area, the incision carried through the cartilage. The cartilage and a small piece of attached bone were then easily lifted out, leaving a crater 1 cm. in diameter. The base of the crater presented a purple, velvety surface, which was freshened with a curette.

The postoperative course was uneventful and the patient was discharged from the hospital on March 12, 1943. A recent interview disclosed the fact that he is now on full duty, but

excused from calisthenics temporarily. No limp was observed but there was a slight limitation of flexion.

**CASE V.** This patient, aged twenty, was admitted to the Station Hospital on January 22, 1943, with an acute appendicitis. An appendectomy was performed on the day of admission with an uneventful postoperative course.

During the patient's stay in the hospital, he was seen in consultation by the orthopedic surgeon, regarding a painful left knee. Physical examination revealed no swelling or tenderness. The knee was stable and there was a full range of painless motion. However, the patient walked with a slight limp.

Past history revealed no indication of trauma, but the onset began in 1938. The pain was present on weight bearing and most severe while walking. The knee occasionally gave way, causing him to fall. Locking never occurred, but a sudden stop in an elevator would cause pain and buckling. Symptoms were grossly aggravated by the army routine.

An oval button of sclerotic bone was visualized in the lateral articular portion of the medial femoral condyle in the x-ray examination made on February 5, 1943. This finding was pathognomonic of an osteochondritis dissecans. No loose bodies were noted in the joint at this time.

An arthrotomy of the left knee was performed on February 17, 1943. A pale, dimpled area,  $1\frac{1}{2}$  cm. in diameter was outlined with a scalpel on the lateral aspect of the internal condyle of the femur and easily removed. The remaining crater was freshened with a curette.

The postoperative course was uneventful and improvement was rapid. The patient was returned to duty with an excuse from calisthenics on March 18, 1943. A recent interview revealed that buckling had not recurred since the operation, but there was still some pain, especially on weight bearing, causing a slight limp.

#### SUMMARY AND COMMENT

1. A résumé of the literature pertinent to osteochondritis dissecans was presented.

2. The importance of early diagnosis and early treatment was stressed to avoid subsequent involvement of disabling synovitis or arthritis.

for primary closure. A few are found to run deeply, infecting the underlying sacrococcygeal ligaments and even the vertebrae of the sacrum and coccyx; removal, or even curetting, of these parts will not permit primary closure. Also, many adherents of the open method still consider it the method of choice in military service,<sup>1</sup> and in civilian practice, where the factors are certainly more compatible with this method, the members of this school are understandingly in the majority.<sup>7,13</sup> Finally, many cases fall into the open wound category as failures of primary closure either as a result of poor surgical technic and/or overwhelming infection or as recurrences.

The process of recurrence is really one of "pseudo-recurrence" for it is generally agreed that a true regrowth of the original disorder is now rarely encountered.<sup>12,14-17</sup> All operators recognize the importance of completely excising every vestige of diseased tissue either by direct visualization and careful dissection or by block excision with or without identification by dye (methylene blue) injection. We believe it is also important to remove the diseased tissue with the least amount of contamination, by sealing the sinus opening (or openings) and taking particular care not to rupture the cyst during excision even when primary closure is not contemplated. The all too common recurrence is in reality a result of one or a combination of many possible artifacts: dead space resulting from improper use of a drain or from poor placement of deep sutures, chronic infection introduced during operation from the cyst and/or operative technic or during the postoperative course, improper hemostasis, poor packing in open cases, the unhygienic location of the wound, and postoperative negligence on the part of the surgeon or the patient.

#### PRIMARY CLOSURE METHOD

Postoperative care for primarily closed wounds is generally routine but modified according to the type of closure attempted.

The most common procedure entails excision of the diseased tissue either in an elliptical block or by careful dissection of the involved areas only. After complete hemostasis with fine sutures a sulfonamide powder—sulfanilamide, plain or buffered<sup>18</sup>—is evenly spread throughout the wound, taking particular care that large collections of powder are not left to act as foreign bodies. Penicillin solution is believed to be even more efficacious; it is squirted into all corners of the wound and may even be injected into the walls of the cavity for short distances in every direction with an ordinary 10 cc. glass syringe and needle. Undermining of the wound edges is frequently undertaken to provide approximation without undue tension. The sutures are then placed in various ways according to the preference of the operator. Usually a deep row approximates the deep edges of the flaps to the fascial floor to eliminate dead space thoroughly; a drain may be inserted at this point, if desired, before tying the sutures. The skin edges are approximated with a few vertical mattress sutures without undue tension. Some authors<sup>3</sup> believe that retention sutures of silkworm gut, silver wire or alloy steel wire tied across the wound or over rolls of gauze are valuable for additional pressure and support. Certainly pressure in some form is necessary to help eliminate dead space and aid hemostasis; sterile mechanic's waste or fluffed gauze dressings are excellent for this purpose. Most operators use tight adhesive strapping for immobility and protection.

From the operating table the patient is immediately rolled over onto his back and is kept in this position for twenty-four hours. During the next three days he is allowed on his abdomen but it is believed he should not lie on his side until the fifth day as this indirect force may shear one edge of the wound from the other. The usual postoperative sedation is given according to the needs of the individual patient and the preferences of the attending surgeon. If a sulfonamide has been

# PILONIDAL CYST

## THE POSTOPERATIVE PROBLEM

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PILONIDAL cyst has become a current surgical problem principally because of World War II and the resultant massing together of thousands of people who fall into the proper etiological group as to age, sex and race, and are subjected to the exacerbating conditions of trauma and strenuous physical activity. The literature is being enriched with many articles dealing with this problem, principally with the matter of operative treatment as a military problem primarily. The search is being made for the method which will hospitalize a soldier for the least amount of time and yet give him a healed wound able to protect the sacrococcygeal region against the unusually severe types of trauma met with, such as riding in jeeps, trucks and tanks, running obstacle courses and going through battle without becoming a "postoperative casualty."

The old controversy of excision and open packing versus primary closure has been renewed.<sup>1-8</sup> The method of primary closure has been given great impetus by the demands of military treatment for it is certainly the method of choice under such conditions. When successfully employed it enables the military surgeon to get the soldier back to active duty in less time and with greater protection against trauma to the sacrococcygeal area than either the open method or any other method yet devised.

Much has been said about the etiology, pathology and treatment of pilonidal cysts but not enough stress has been laid on the importance of postoperative care, regardless of the method of treatment employed, as related to proper healing and recur-

rences. This paper deals with this latter problem, especially as it applies to open wounds, whether they are a result of (1) excision and open packing, (2) partial closure, (3) a primary closure which has had to be reopened, (4) recurrences, (5) injuries to the healed scar, or (6) failure of any of these types of open wounds to heal. For certainly, the kind of postoperative care given will determine not only the healing time but, as important, the type of scar resulting and consequently the likelihood of recurrences.

The goal of primary closure methods is to eliminate the problems attendant upon open wound care and concentrate on those problems peculiar to closed wound healing such as complete removal of diseased tissue, absolute hemostasis, obliteration of dead space, accurate approximation of wound edges without undue tension, postoperative "wound sanitation" and protection from traumatizing factors until healing is complete. New procedures are being devised and tested on large groups of patients, particularly in the military hospitals,<sup>8-12</sup> to master these problems, and new agents are now available to combat the infection usually present in pilonidal cysts and, until now, the chief contraindication to primary closure. The sulfonamides, used both locally and systemically, have made the problem a much easier one, and if penicillin can be made available for such use it may markedly affect the percentage of cures by primary closure. However, the problem of open wound care will yet be the greater one for many reasons. Many pilonidal cysts with ramifying tracts and multiple sinus openings are too extensive

and the size of the cavity to be filled in. The patient is kept on his back for the first twenty-four hours for the same purposes as stated above. However, he is allowed out of bed on the second day and no attempt is made to control the bowels; a regular diet is given at that time and catharsis when indicated. Sedation is given when necessary but there is little postoperative discomfort from either of the operative procedures mentioned.

For the first few days there is a large amount of gelatinous discharge containing tissue and blood débris, necessitating daily dressings. When the "necrotic cast" of the cavity has been shed, healthy granulation tissue is already found to be filling in the defect. The rate of granulation depends upon many factors which influence healing in all the types of open wounds to be discussed.

*The healing ability of the patient* is not a factor that can be quantitatively measured but is an individual characteristic that can be clinically observed. Frequently we see, under the same conditions of environment and diet, one patient heal in half to three-fourths the time required for the average case. At the other extreme I have observed a patient, a white male aged twenty-three years, who had been hospitalized for fifteen months and subjected to several surgical procedures without complete healing ever having resulted. Exhaustive studies had not determined the causative factor. Certainly, special diets high in vitamin intake, stressing vitamin c, should be part of the postoperative regimen in all cases of delayed healing. Light exercise, a convalescent environment and freedom from worry are factors to be striven for, when feasible, to enhance those natural qualities possessed by the patient.

*Neutralizing the infection* always present is directed principally at those organisms usually cultured during healing: staphylococcus, streptococcus, pneumococcus and pyocyanus. Until penicillin can be made generally available for this use it is believed that the sulfonamides, locally

and orally, offer the best means of combating the initial bacterial "mass invasion." However, they should not be used locally more than a few days for we have observed, as has Tendler,<sup>14</sup> that an unhealthy looking gray granulation tissue forms which heals slowly. There are many agents to choose from for initial wound antisepsis with, or in place of the sulfanilamide powder suggested: iodoform gauze packing, azochloramid in triacetin (1:500) impregnated gauze, mercurochrome, chlorazene, Meleney's zinc peroxide, BIPP gauze, etc. When dressings are changed, irrigating with Dakin's solution, azochloramid solution, peroxide, saline, boric acid solution or distilled water removes most of the necrotic material. I have not used the whirlpool bath here but in view of my experiences with it for cleansing sloughing third degree burn wounds<sup>29</sup> I deem it worthy of trial. After one week the discharge is usually light and it is believed that infection has also diminished. A thought is now given to stimulation of healing properties and such agents as Brezin's sulfathiazole, cod liver oil, lanolin ointment,<sup>9</sup> 5 per cent sulfadiazine in vaseline or aquaphor, or any of the sulfonamide-urea products are used until the infection problem is superceded by that of wound healing alone.

*Wound control* requires a constant "devotion" to the problem of policing a progressive yet indeterminate process. At this point the surgeon's skill may influence the final result in as much a degree as his skill in the operating room. The cavity has now decreased in size and depth presenting healthy granulation tissue on all sides and along the base. The list of agents available to promote healing is familiar to every surgeon: cod liver oil, balsam of Peru, scarlet red, Lassar's paste, etc. The important point to be made is that regardless of the agent selected it must be used to its greatest efficiency for a satisfactory result. It is a common observation that different cases respond in different degrees to the same

given orally for two to three days prior to operation (we prefer sulfadiazine, 4 Gm. daily), it is continued for the same length of time postoperatively or longer when indicated. We find this valuable, in conjunction with the sulfanilamide powder (or penicillin solution) used locally, for those cases presenting grossly infected cysts. A liquid diet is given for two days, a soft diet the third and fourth days, followed by a regular diet thereafter. Six 4 cc. doses of paregoric are given at four-hour intervals to discourage bowel movements. On the morning of the seventh day a lubricating type enema is given and at the same time cascara sagrada, 4 cc., in mineral oil, 30 cc. is given orally. The patient is first allowed out of bed for bathroom privileges on the tenth day provided there is no contraindicating wound disturbance.

The dressing is changed the first day to remove the drain if one has been used, otherwise in the absence of evidence of wound infection it is not inspected until the fifth day. At that time the removal of sutures is left up to the judgment of the surgeon as regards the healing of the wound. Usually all the skin sutures are removed if retention stays are present. Every other suture is removed if there is any doubt of complete healing. If there is evidence of infection around the suture or necrosis of skin edges, the guilty sutures are removed. The original type sterile pressure dressing used in the operating room is then reapplied. Inspection of the wound every two or three days is essential if complications to good healing are to be combatted at their inception. If evidence of infection deep in the wound presents itself, the wound is opened without delay. Frequently only a portion of the wound need be opened and thus a partial closure remains.

The extent of the area to be reopened is best determined by gentle probing into the depths of the wound and up and down the healing tract. A minimum of healing should be broken down, particularly near

the deep layer of sutures, but at the same time good healing by granulation will not proceed until all pockets, tracts and overhang are broken down to form a smooth-walled cavity with adequate drainage facilities.

Occasionally, a borderline case presents itself which to the average observer is not suitable for primary closure. We believe that a primary closure may be attempted with the reservation that it can always be reopened if primary healing does not take place because (1) no time is lost, (2) frequently the approximation for even a few days helps by decreasing the space to be filled in by granulation, (3) the resulting scar is usually stronger and (4) if primary healing does occur it is more than "worth the chance." Weeks and Young<sup>12</sup> have observed that healing occurs faster in a reopened primary closure than in one left open originally.

The final problem with closed cases is the return to active duty. This problem, not met with in civilian practice, is the "acid test" of primary closure. There have been surprisingly few recurrences among the patients returned to duty two to four weeks after operation.<sup>3,5,9,11,12,18</sup> The patient is left with a more normal pad over his sacrococcygeal region and a narrow, strong scar, a much more desirable situation for the rigors of military life than the thin, wide scar of the open method. However, in civilian practice it is advisable to keep the patient from all activity involving the operative site for one month, allowing return to full physical activity (horseback riding, truck driving, etc.) in three months from the time of operation.

#### OPEN PACKING METHOD

When block excision with open packing is the procedure chosen, the immediate postoperative care is simplified but late care is occasionally complicated. A large defect usually remains, packed with iodoform or vaseline gauze. Wide adhesive strapping is used to decrease the tension

consider this method applicable only to the cases in which primary closure cannot be attempted even by "taking a chance" of partial reopening, and yet considerable healing time could be saved by closing either or both ends of the wound. The case with a large infected cyst and long, winding, narrow sinus tracts is best attacked by this procedure, closing the tract defects primarily and allowing the large cyst defect to granulate in slowly.

Whether a partially closed wound results from operation or from the reopening of part of a primarily closed wound, the postoperative care is essentially that of the open wound already described. Certain features require special attention. Because a closed wound exists adjacent to the open area the sutured region is protected from contamination as much as possible; hot Sitz baths serve admirably here for both types of wound present. Tunneling from the open area into the recesses of the closed section is the rule unless constant wound control is maintained. The open cavity is usually quite narrow in partially closed cases so that "bridging" is a characteristic complication; it is a result of epithelization across the narrow gap prior to complete granulation of the wound. The result is a thin, false scar that conceals infectious débris. This is a frequent cause of recurrence, for so quickly does this "skin" form that the attendant will find the wound completely "healed" since the last inspection two days previously and discharge the patient as cured. It requires but light physical activity to split the membrane but this may not occur for a week or two, during which time the infectious process beneath has ample time to form a deep, undermined crater with tunneling sinuses. This is best prevented by recognizing the membrane, often by its blue-gray color, and removing it. It is wise to suspect any tissue formed too quickly, whether epithelization or granulation. If a flexible probe—a whale-bone probe is excellent—is held in the hand during each dressing, the tendency to use

it will reward the surgeon with surprising discoveries.

As with the primary closure method, a word of caution to open the adjacent closed portion immediately should evidence of infection appear in this region; open well beyond the involved area and tend to "saucerize" to prevent recurrent undermining of the edges, saving as much sutured portion as is safe.

#### MISCELLANEOUS METHODS

Cutler and Zollinger<sup>25</sup> have had success with a modified Carnoy's solution for sclerosing pilonidal cysts and sinuses. In the hands of Rogers and his associates<sup>17, 26, 27</sup> the fractional cautery excision has yielded excellent results. Both procedures result in an open wound which is treated much the same way as mentioned, the sclerosed lining in the former method first being curetted out.

#### TRAUMATIZED SCARS

Occasionally, following discharge the patient returns with a sharp crack or split in the scar or a more superficial irritation. This usually occurs during the first month following healing and a history of a bumpy truck ride, 500-mile train trip or the like is supplied. This type of injury is not serious and is more commonly seen in the wide thin scars of the open packing method. Treatment consists of a thorough cleansing, including shaving of all adjacent hairs, and application of any bland ointment—10 per cent boric acid ointment. A small piece of absorbent cotton stuck to the ointment will suffice as a dressing. Healing is complete within a week.

#### RECURRENCES

The factors responsible for recurrences have already been discussed. Where a small area is involved, it need only be opened beyond the undermined edges and the walls and floor débrided with a small scalpel blade or curette; it is then treated as an open wound. The entire procedure may be done without anesthesia. If the

agent so that after a fair trial and failure it should be replaced by another. Then, too, an efficacious agent may help up to a certain point and then be useless or even obstructive to further healing. After the unsuccessful use of complicated and often expensive compounds the attendant is often amazed to see a change to plain vaseline or boric acid ointment speed the healing on its way. Hot Sitz baths, two to three times daily, have long been a favorite of postoperative care, starting within a day or two after surgery<sup>7,14</sup> or later when other methods fail, and is now being used routinely for primary closures by Weeks and Young.<sup>12</sup> It is not without certain disadvantages. Because the patient is responsible for his own care, the efficiency of this method is proportional to the patient's intellect and diligence. The surgeon must be prepared to inspect the healing process regularly or pocketing and undermining will occur and the resultant scar will cover a multitude of defects. He must be familiar with the use of other agents and not hesitate to change over should healing become stationary.

Excessive or irregular healing is frequently a problem in wound control. Kleckner<sup>7</sup> believes the altered blood supply is responsible for peculiar types of healing. Where granulations rise above the level desired for proper epithelization, they are burned down with the caustic stick or leveled with scissors; where the rate of growth is but slightly excessive, a dressing of nickel pectinate serves to slow down granulation. Tendency to undermining or pocketing must be broken up constantly so that healing is solid, or recurrences will result.

If at any time evidence of infection overwhelms the healing process, a short recourse to any of the initial "wound cleansers" will prove adequate.

*Wound sanitation* requires a change of dressing every two to three days and whenever the dressing becomes soiled from a bowel movement. Because of the location of the dressing in the intergluteal

fold one is sure to find debris consisting of hair, clothing lint and epithelial scales in the wound. All such material is thoroughly cleansed from the wound at every dressing. The pilonidal cyst is more commonly found in patients with an excess of body hair<sup>19,20,21</sup> so that it can be expected to grow around the edges of the wound in seven to ten days post-operatively. These hairs are carefully shaved away whenever they appear, for they prevent epithelization where they exist and thus plant the seeds of recurrence. We have not found it necessary to use exfoliating doses of x-ray for this purpose but for a recent case of hyperhidrosis of this region x-ray was attended with good results. Surrounding infection from adhesive strapping is best controlled by applying tincture of benzoin to the skin before strapping. Succeeding layers are placed over the first adhesive in as many layers as permissible. Where skin excoriation is marked, a tight muslin binder is substituted and the excoriated area covered with strips of sulfadiazine impregnated gauze. Dressings are large enough to cover the wound completely, thick enough to absorb all anticipated drainage and secured firmly enough to prevent slipping and contamination of the wound.

*Trauma prevention* is obtained through proper dressing of the wound and explicit directions to the patient as to the type and amount of activity he may engage in. For one month following healing the scar is protected with a small strip of absorbent cotton held in position by the patient's underwear; during this period activity is gradually increased. The military patient is then returned to active duty. The civilian patient is advised to wait an additional month or two before undertaking full physical activity.

#### PARTIAL CLOSURE METHOD

Several authors<sup>16,20,22,23,24</sup> advocate a partial closure of the defect, with or without drainage, for all cases adaptable. We

cysts. Diligent postoperative care is the chief prophylactic measure.

4. The postoperative problems peculiar to each method of surgical management are discussed and a plan of care outlined for each.

5. The refractory case presents a difficult healing problem which must be carefully investigated for the causative factor. Several remedies are mentioned.

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greater part of the wound is involved, it is best to reoperate and excise the entire area, and attempt the closure deemed most likely to give a complete cure. This decision frequently depends on the cause of the recurrence, for when due to an unusual injury and not a result of poor healing a primary closure can be considered. However, the greater percentage of recurring cases, originally closed or left open, will finally come to either a partial closure or open packing regardless of the time that will be lost, for the requirements of healing are easier to meet.

#### REFRACTORY CASES

Every series of surgically treated pilonidal cysts contains a few refractory cases upon which repeated procedures have effected no permanent cure. A complete study of the patient as a whole is the first step to be taken, bearing in mind those entities linked with poor wound healing: tuberculosis, syphilis, malignancy, vitamin c deficiency, etc., and then a search for local causes: fungus infection, anaerobic infection, osteomyelitis of the sacrococcygeal vertebrae, rectal disorders,<sup>28</sup> communication with spinal contents (rare), etc. In all cases, preoperatively, we advocate routine x-rays, anteroposterior and lateral, of the sacrococcygeal spine and careful rectal examination. In refractory cases these are repeated and a chest plate ordered. The injection of lipiodal may expose deep pathological conditions. We do not use it preoperatively as a routine procedure but only when indicated. Blood chemistry, including a vitamin c blood level, is often instructive. Repeated culture of the wound frequently reveals the responsible organism. A biopsy of the broken down tissues is essential, and when reoperation is performed the excised tissues are subjected to microscopic study and culture.

Certain local agents prove effective in many cases when expertly employed. Where anaerobic organisms are cultured, Meleney's zinc peroxide therapy, coupled with peroxide irrigations, is valuable. For

fungus infection the ordinary salicylic acid-sulfur preparations will suffice. Quartz lamp therapy is occasionally able to arouse healing properties and the use of x-ray for local hyperhidrosis has been mentioned. We have had an opportunity to try many new agents advocated for refractory wound healing but none deserves special recognition as yet. Skin grafting is recognized as a good procedure<sup>12</sup> but it should be used more often and earlier than is the custom.

The healing ability of the patient must again be mentioned as a vital factor which when stimulated can produce unexpected results. We have all seen the refractory case sent on furlough, or vacation, for a month, return with his general health built up and the wound soundly healed.

In the military service there is still another factor to be thought of when confronted with a wound which to all intent should heal but remains dormant. The soldier who does not wish to return to duty will, in rare instances, prevent healing of the wound by engaging in prohibited strenuous exercise in order to break down healing tissues, or irritate and contaminate the wound by some simple method. Where suspected the evidence can usually be detected. The treatment must then be supplemented with enforced bed rest and well padded dressings secured firmly with adhesive strapping.

#### SUMMARY

1. Military requisites demand a method of treating pilonidal cysts that requires little postoperative care and furnishes a well healed protective scar. Recently developed technics of excision and primary closure of selected cases in conjunction with sulfonamide therapy offer the best solution of this problem.

2. The more conservative method of excision and open packing is indicated in many cases not amenable to radical surgery. In civilian practice it is the surgical procedure of choice.

3. Recurrences are common following all types of surgical treatment for pilonidal

route; lesions of the upper rectum and especially those of the anterior wall are satisfactorily treated by the Bevan opera-

mended. In certain of these cases, the surgeon may encounter a patient who does not present a satisfactory risk for the

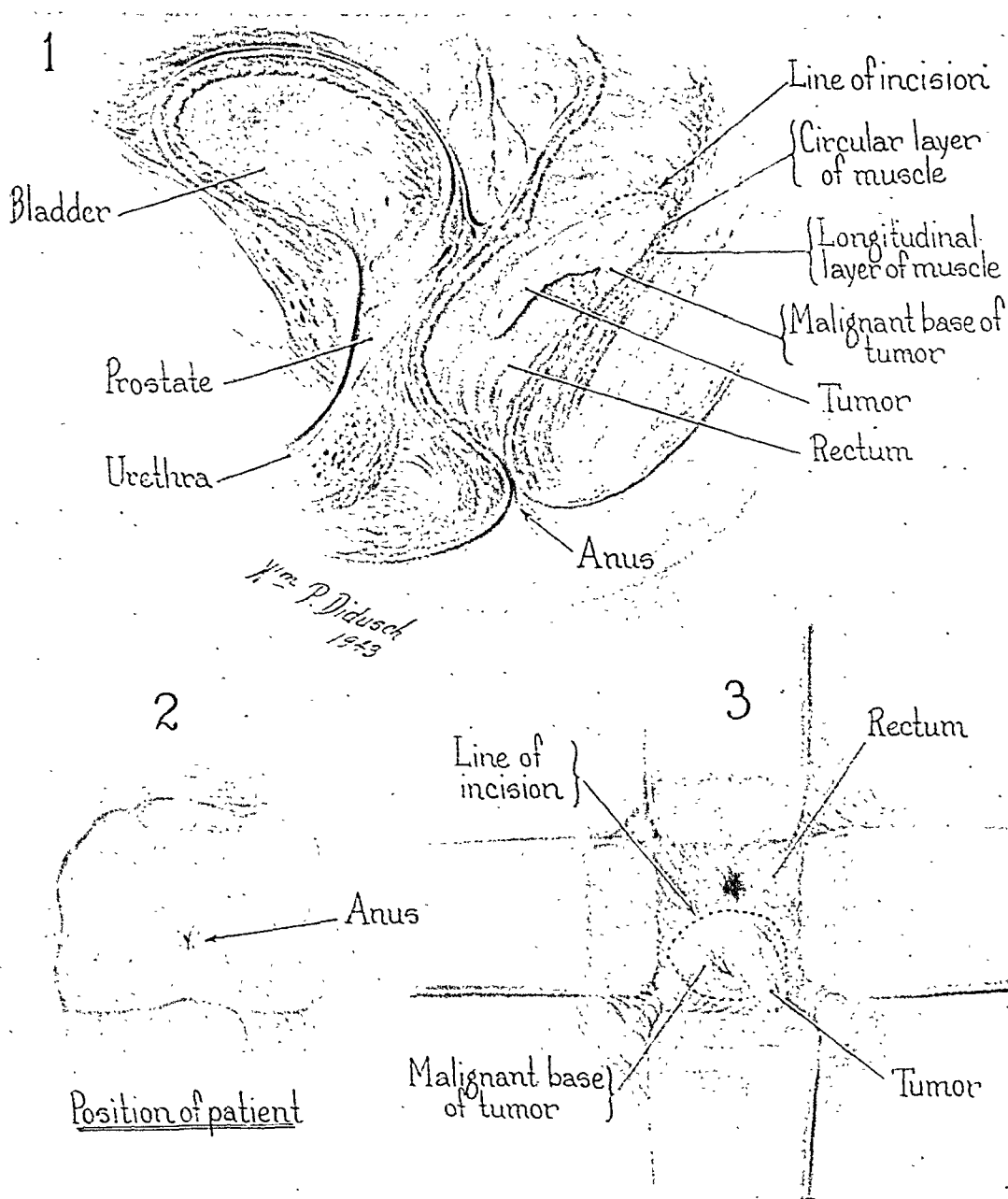


FIG. 1.

tion; for those lesions involving the lower five inches of the rectum, but only those located on the posterior and posterolateral walls, the technic described by the author is best suited. However, for those cases showing malignant changes which extend from the base through the submucous layer of the rectum, the radical combined abdominal-perineal resection, either as a one- or two-stage procedure is recom-

radical abdominal-perineal procedure. The author wishes to report a case of a seventy-year old male, who clinically did not present a good risk and was treated with the operative technic described below:

#### CASE REPORT

The patient, Mr. L. D. S., first came to the clinic June, 1939, for a usual yearly check-up. Examination revealed a small thrombosed

# CARCINOMA OF THE RECTUM

## CONSERVATIVE SURGERY IN CERTAIN INSTANCES

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THE treatment of malignant and of potentially malignant diseases today is based on principles that have reached a high degree of standardization. At the present time more attention is given to the potentially malignant disease in an effort to eradicate this condition before deep-seated infiltration and secondary metastasis have occurred. This is most applicable to early lesions of the rectum and lower colon.

Polypoid disease of the rectum and colon fall under two definite but not clearly differentiated types, mainly multiple and solitary. The latter type is more commonly found located in the rectum and lower sigmoid. Staemmler, from a series of eighty cases, reported 58 per cent in the rectum and 13.2 per cent in the sigmoid.

Malignant change in the base of polypoid growths of children is not infrequent. Bacon found eight cases of patients under the age of twenty years out of a series of 1,995. One patient, four years and seven months of age, showed early malignant change in a polyp removed from the rectum.

Phifer, in a series of forty-nine cases, found twenty-two patients with malignancy under fifteen years of age; twenty-seven patients were between the ages of fifteen and twenty years.

Schmeiden and Westhue's classification of polyps described three histological forms: The first benign type is usually a solitary lesion made up of an abundant tissue stroma, covered by a normal mucous membrane layer of epithelium identical with sigmoid or rectal lining. A second group is composed of a similar stroma covered with a more atypical cellular mucosa showing some undifferentiated

areas. The third precancerous type exhibits an irregularly arranged epithelial covering and shows a definite lack of differentiation of the epithelial cells. The portion of the tumor undergoing malignant change is the base and may be suspected clinically by its raised and indurated appearance. To this classification a fourth group can be added, namely, that type of solitary polyp which shows definite malignant changes at the base and not showing any evidence in the stalk. Early diagnosis of this latter type before invasion of the submucosal layer is extremely important. As already stated above the greatest percentage of polyps is located in the rectum and the sigmoid, and they are associated with precancerous and actual cancerous changes.

The author believes that more emphasis should be put on the routine examination of patients especially in reference to the study of the rectum and colon. This can be carried out readily by routine proctoscopy and sigmoidoscopy at six-month intervals. Barium enema with fluoroscopy and x-ray may be added for study of the higher colon if desired. In carrying out this procedure once a polyp is found in the early stage of change. It can be treated conservatively and with little loss of time and expense to the patient.

The surgeon, having found the solitary polyp in the rectum or sigmoid, should immediately ascertain the degree of the disorder. This is best obtained by taking two or three biopsy sections from separate areas of the tumor base. Strictly benign lesions and those classified by Schmeiden and Westhue as showing precancerous changes can be treated according to their location: Lesions of the sigmoid and rectal sigmoid are best treated by the abdominal

Physical examination revealed the head and respiratory systems to be normal.

Pulse: The pulse was regular with good

hemoglobin, 60 per cent; erythrocyte count, 3,100,000; leucocyte count, 8,000; there were 64 per cent polymorphonuclears, 18 per cent

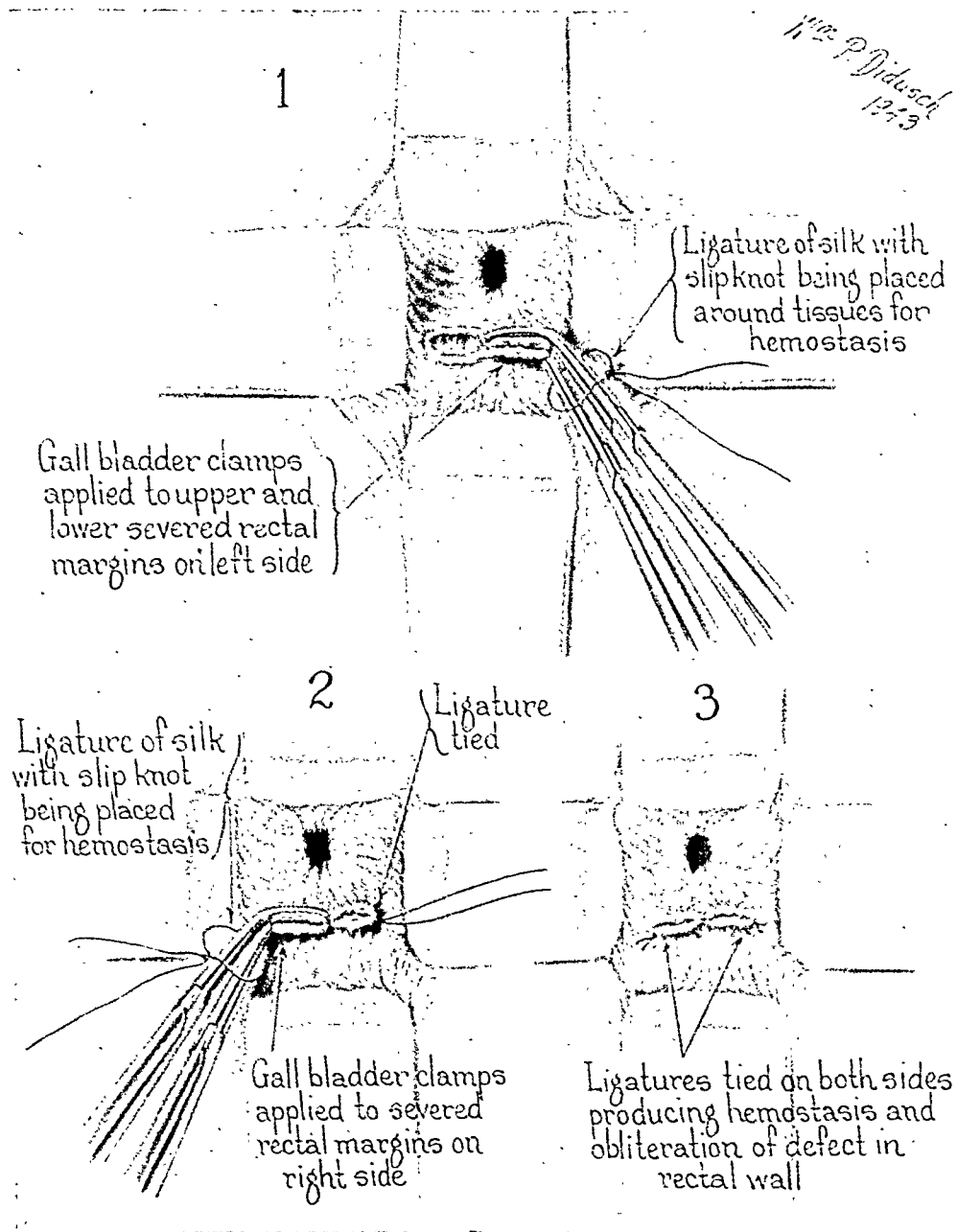


FIG. 3.

volume. The blood pressure was 140/60. There was slight enlargement of the heart on percussion and flouroscopy. There were no organic murmurs. The abdomen was retracted. There were no visible or palpable masses or palpable inguinal nodes. The external genitalia were normal. The prostate gland felt irregular in shape, considerably enlarged, and had moderately firm consistency. Urinalysis was essentially negative.

The blood picture revealed the following:

small lymphocytes, and 8 per cent large lymphocytes; eosinophils were negative.

Morphine sulfate,  $\frac{1}{2}$  gr. hypodermically, was given one hour before the operation. The patient was placed in the lithotomy position and 50 mg. of metycaine were given intraspinally.

Twenty minutes after the administration of the spinal anesthesia, the anal sphincters were gradually dilated by digital means. Malleable retractors were then inserted at the upper and lateral angles of the dilated anal orifice. A

external hemorrhoid. Digital examination disclosed a large movable mass 8 cm. up on the posterior wall of the rectum. Proctoscopic

showed secondary budding lined by papillated epithelium. The lining epithelial cells were large, columnar in type and had moderately

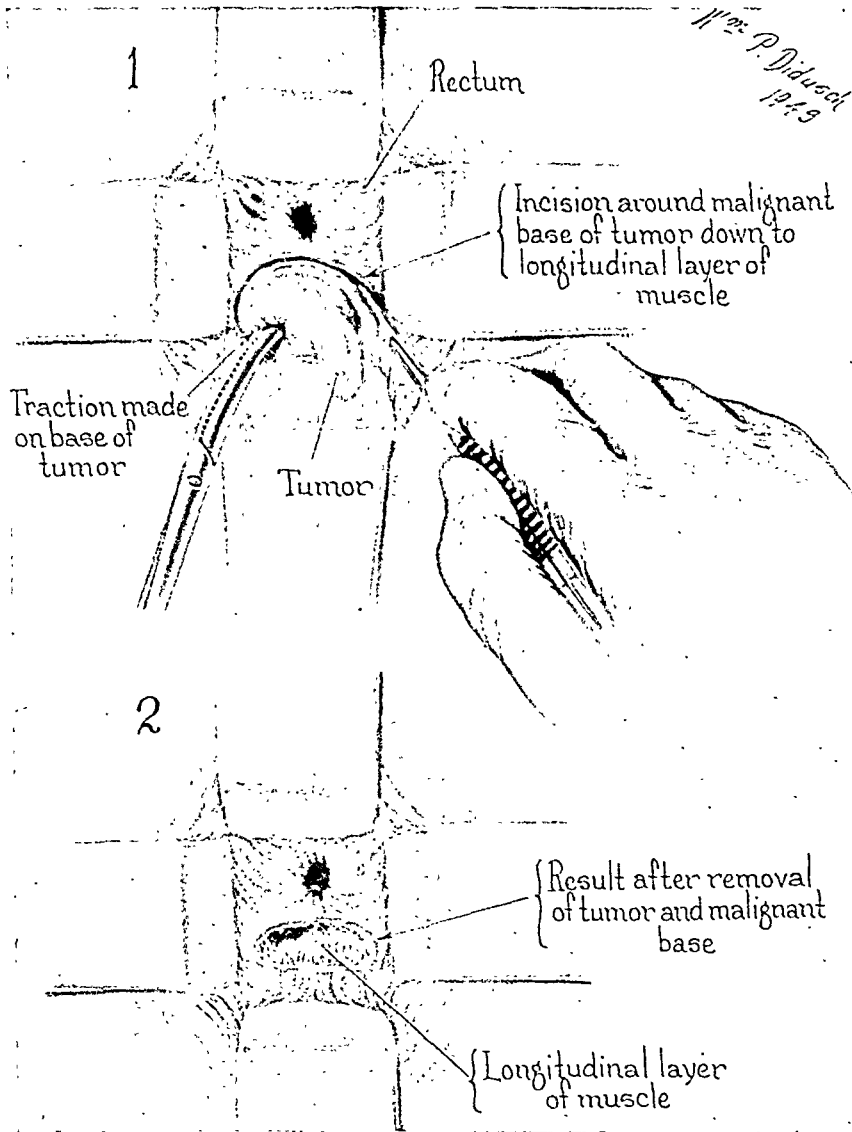


FIG. 2.

examination showed a normal rectal sigmoid junction and an entirely normal rectum, except for the presence of a polypoid mass in the posterior wall. It measured exactly 3.5 cm. in length. The base of the tumor was elevated and indurated and appeared somewhat congested. Two biopsy specimens taken from separate parts of the indurated base revealed the following pathological changes:

Microscopic section showed a moderate number of polyp-like pieces of tissue, covered by atypical tubular glands. Many of the glands

large hyperchromatic nuclei. The connective tissue core of the largest polyp showed slight infiltration of atypical epithelial glands. There was also fibroblastic proliferation and lymphocytic infiltration. Another section showed gigantic atypical tubular glands lined by papillated columnar cell epithelium. A moderate number of mitotic figures were seen throughout. Diagnosis: Rectal tissue: Adenocarcinoma (adenoma destruens); chronic, cellular and productive infiltration.

or cancerous in nature. Many cases of solitary polyp have undergone malignant change before the main objective sign of bleeding has appeared.

Many radical surgical procedures and fatalities may be avoided by the early diagnosis and eradication of the potentially malignant polyp. This can best be accomplished by the including of proctoscopy and sigmoidoscopy as a part of routine physical examinations every six months.

Because of the malignant change first appearing in the base of the polyp, the operative procedure of choice for those cases located on the posterior wall of the lower rectum is described above. The present tendency toward the electrosurgical treatment of these lesions as an office procedure is far from being adequate.

Surgical excisions under spinal anesthesia as a hospital procedure is strongly advised.

It is well to remember that malignant changes also occur in polypoid growths found in the rectum of children.

A case showing early malignant change

in the mucosal base of a rectal polyp is reported with a fifty-month apparent cure to date following surgical removal.

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heavier similar retractor was then inserted along the posterior and anal-rectal wall up to the base of the mass which bulged forward into

Eight days following operation, a large one and one-eighth inch bore proctoscope was inserted and the raw puckered margins of rectal



FIG. 4.



FIG. 5.

FIGS. 4 AND 5. Microscopic sections.

a clearer view. (Figs. 1, 2 and 3.) Following this, a long eight-inch clamp was loosely inserted into the base and with mild traction a transverse elliptical incision was carried out above and below the base of the polyp, so as to meet on each lateral side. These incisions were carried down to the longitudinal muscular coat. The polyp and base were removed intact.

Considerable bleeding was encountered and immediately controlled by applying a narrow gallbladder clamp to the upper and lower severed rectal margins on each side. The space did not permit suturing, so a slip knot tie of silk was inserted over the handles of each clamp on one side and when properly placed beneath the clamp ends, was firmly drawn together and the clamps slowly removed. Similar ligation was carried out on the opposite side. This afforded excellent hemostasis. Following this, a dry gauze pack was carefully inserted well above the operation site and one end allowed to protrude from the anus.

The patient was kept in bed for four days, during which the routine, postoperative hemorrhoidal diet was carried out.

mucosa were carefully cauterized down to a level of the adjacent mucosa. Very little bleeding was encountered. The patient was proctoscoped six weeks later and a very satisfactory linear scar was present with no evidence of stricture.

Following this, it has been routine to proctoscope the patient at four-month intervals, and up to the present date, which is a total of fifty months, there is no evidence of recurrence at the site of operation, or impairment of general health.

Sixteen months later, the patient entered the New York Hospital on the Brady Urological Service, where a transurethral resection and bilateral partial vasectomy was carried out. The patient was discharged at the end of two weeks much improved.

The pathological diagnosis was as follows: Benign hypertrophy of the prostate; chronic prostatitis.

#### CONCLUSIONS

Polypoid tumors of the rectum and colon are all to be regarded as precancerous

Zephiran has a surface tension one-half that of distilled water.<sup>7</sup> This is of importance since the low surface tension indi-

similar chemical structure, of quaternary ammonium salts, has important interface modification properties. Long before their

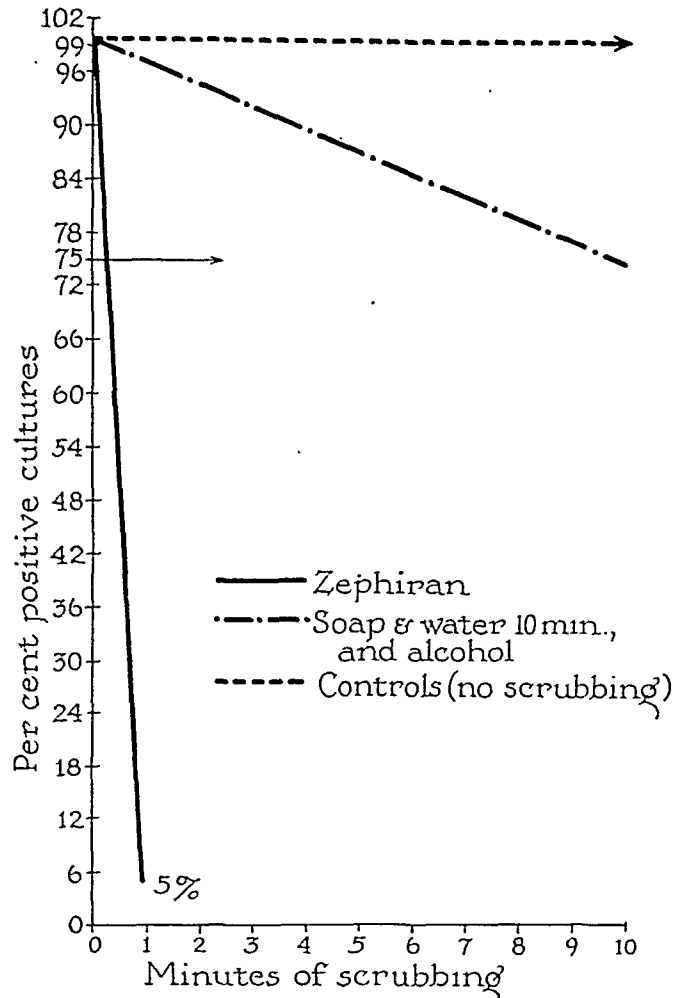


FIG. 2.

cates the penetrating power. In this connection, White, Collins and Newman<sup>8</sup> made full thickness biopsies in which the skin was prepared with the solution. In fifty-one cases in which biopsy cultures were taken from such treated skin, growth occurred in two instances; biopsy cultures of untreated skin showed growth in every case. The substance, as pointed out by Dunn,<sup>9</sup> is very stable; neither freezing temperatures nor prolonged exposure to heat (122°F. to 50°C.) caused any reduction of its germicidal action. Storage at room temperatures for more than eight months caused no alteration in its germicidal properties.

Zephiran is an emulsifier and a detergent and like the other substances which have a

bactericidal action was known they were used as emulsifiers, detergents and wetting agents. In preparation of the skin for surgery, these substances, as Walter<sup>10</sup> has demonstrated, possess a detergent, karatolytic, emulsifying and emolient action. The cleansing action is evident when it is used to wash dirt and grime from the hands; it is more effective than soap and water for the same length of time. Tests to compare detergency values have been made, using Zephiran and similar products against soap solutions. Soiled wool cloths were washed, one with soap and water, and the other with Zephiran solution. The reflection of light from the cloth was then measured. The amount of reflectance was then expressed in percentages. The



# CATIONIC DETERGENTS AS ANTISEPTICS

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THE advantages of cleanliness in the care of wounds were observed in the earliest stages of surgery. The introduction of antiseptic procedures by Lister marked a new era in surgery. Ever since Lister's time the search for an ideal antiseptic has been going on. We have gone through various phases of new antiseptics, but each time they have fallen short of the hoped-for requirements. At the present time re-emphasis has been placed, and properly, upon the action of the living tissue as the best antiseptic action against invasive bacteria.<sup>1</sup> The emphasis now is on cleansing the wound with non-irritating substances like soap and water,<sup>2</sup> the forming of the débridement to remove the devitalized tissue, insuring adequate drainage by opening the fascial spaces, and complete immobilization of the tissue<sup>3</sup> with compression to prevent edema. The introduction of the sulfonamides and penicillin have again aroused the hopes for a miraculous substance to cure all infections. Some disadvantages of the sulfonamides are now well established. Penicillin has not yet been used in sufficient quantities to establish its full value; certainly it promises a great deal.

We wish to draw more attention to a new group of antiseptics, one of which we have found to be an excellent preoperative preparation as well as an antiseptic and cleansing material in the dressing of wounds, both in clearing up infection and in the prevention of infection. This disinfectant was first described by Domagk in 1935.<sup>4</sup> A series of chemical derivatives had been previously developed as detergents. The group is designated by following formula in Figure 1:

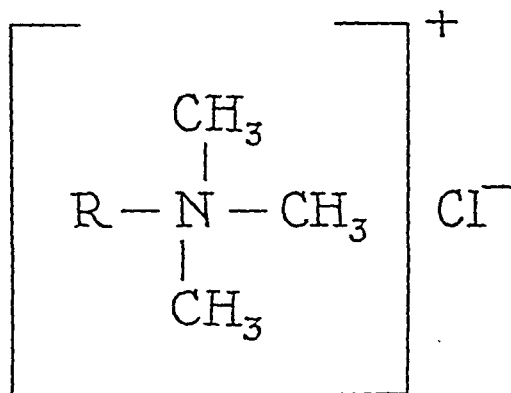


FIG. 1.

They are ammonium chloride derivatives with an R radical consisting of an alkyl radical of about 12 carbon atoms. A series of these products was developed<sup>5</sup> in the laboratory and tested for their bactericidal effectiveness.<sup>6</sup> The preparation that was finally developed as the most effective disinfectant was a water solution of a high molecular alkyl dimethyl benzyl ammonium chloride. This substance goes under the trade name of Zephiran.

Domagk first pointed out some of the physical properties. It is a colorless, odorless fluid which foams upon shaking. It is slightly alkaline to litmus. It does not precipitate with alkalis, remains clear when tap water is added, and there is no precipitate or loss of disinfectant power with the addition of acids. The substance is compatible with iodine, cocaine, ephedrine, epinephrine, procaine hydrochloride, sulfonamides and with most substances with which it is likely to come into contact. It is incompatible with soap; to get its greatest disinfectant value it must, therefore, not be combined with soap. Since Zephiran has the qualities of soap and water, and is an excellent detergent, there is no need to use soap and water.

obtained with Zephiran diluted 1:50,000. After the two and one-half minute test they obtained no further growth in the material upon letting it stand, so that apparently it was not a bacteriostatic action. Furthermore, twenty-four hours later they added fresh cultures of the bacteria in great numbers, and found that further growth of the bacteria was prevented. Further work in determining the bactericidal effect has been carried out by other investigators. Dunn<sup>9</sup> reports a bactericidal effect in high dilutions of organic ammonium chlorides. He expressed the average values for the highest dilution of organic ammonium chlorides destroying the organism in ten minutes, in the following chart:

HIGHEST DILUTION OF ORGANIC AMMONIUM CHLORIDES DESTROYING THE ORGANISM IN TEN BUT NOT IN FIVE MINUTES (AVERAGE VALUES)

Organisms	20°C.	37°C.
Staphylococcus aureus.....	1-20,000	1-35,000
Escherichia coli.....	1-20,000	1-40,000
Eberthella typhosa.....	1-20,000	1-70,000
Streptococcus hemolyticus....	1-40,000	1-95,000
Streptococcus viridans.....	1-35,000	1-65,000
Cryptococcus hominis.....	1-24,000	1-70,000

He ran a similar series of tests checking the phenol coefficient of the organic ammonium chlorides in 1:1,000 dilutions. He reported the following phenol coefficients:

PHENOL COEFFICIENTS OF ORGANIC AMMONIUM CHLORIDES

Organisms	(1-1000 dilutions)	(F.D.A.)	
		20°C.	37°C.
Eberthella typhosa.....	..	250	429
Staphylococcus aureus.....	..	279	408
Escherichia coli.....	..	160	358
Streptococcus pyogenes.....	..	...	272
Streptococcus hemolyticus...	..	435	579
Streptococcus viridans.....	..	384	434

The phenol coefficients of Eberthella typhosa have also been reported by Maier and Miller,<sup>11</sup> who found them to be 150 at 20°C. Heineman<sup>7</sup> reports the phenol coefficient of the same bacteria as 275 at 37°C., Lawrence<sup>12</sup> as 250 at 20°C. For Staphylococcus aureus the phenol coefficient has been reported by Heineman as 275, by Maier and Miller at 200 and by Lawrence at 365, at 20°C.

Dunn<sup>9</sup> also showed comparative figures with the ordinary antiseptic preparations used at the present time, showing that the ammonium chloride preparations were much more effective. Another comparative study was made by Thompson, Isaacs and Khorazo,<sup>13</sup> who showed that the Zephiran chloride acted with much greater rapidity. It has also been demonstrated that there is some retardation of the effect in the presence of organic matter, but this is comparatively much less than other germicidal products. Its effect has been found to be decreased less by egg white media than any other disinfectant in use.<sup>14</sup>

A comparative study of the bactericidal effect of several types of the detergents was made by Baker, Harrison and Miller,<sup>15</sup> and they found that the cationic detergents exhibit a marked bactericidal effect on gram-positive organisms and a somewhat less action on gram-negative organisms, whereas the anionic detergents were germicidal only against gram-positive organisms and were considerably less effective than the cationic compounds.

In a group of experiments which we ran, the concern was with the preoperative preparation of the hands. Two to four cultures of the hands were taken each day as follows: two (or one) of our staff scrubbed in soap and water for ten minutes, following which they soaked the hands in alcohol (75 per cent), and then sterile water, in the usual manner. The other two (or one) of our staff washed their hands in Zephiran chloride for one minute without the use of brush, cloth or gauze. The hands were dried in the accustomed way and placed upon blood agar plates. Twenty

comparative study showed that .03 per cent Zephiran with the chemical formula—alkyl dimethyl benzyl ammonium

static action. Pure cultures of highly pathogenic bacteria were utilized to test the disinfectant action by Domagk<sup>4</sup> and

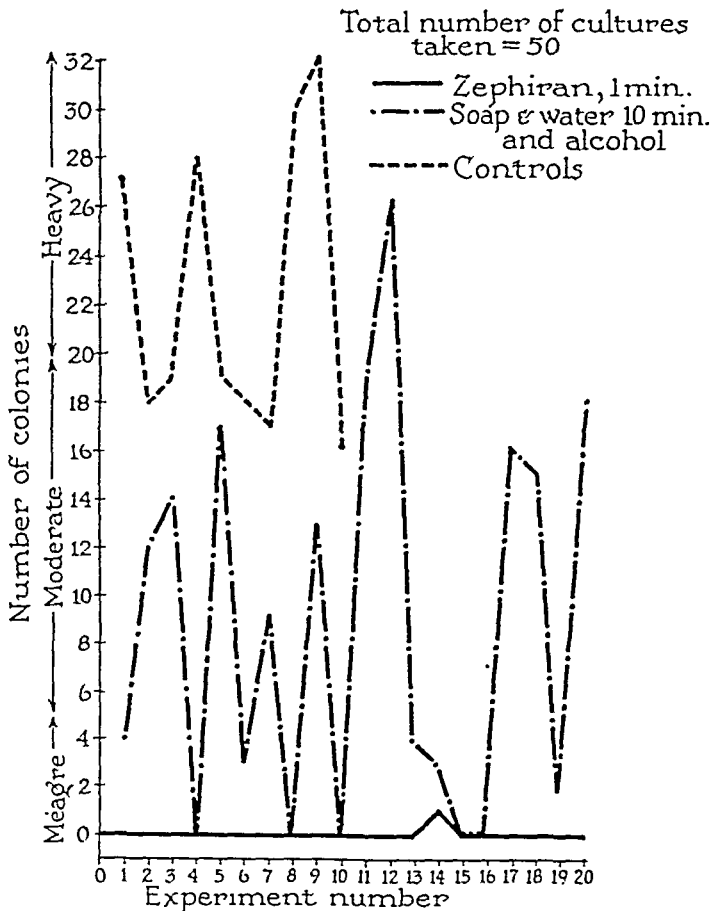


FIG. 3.

chloride—gave 16 per cent reflectance, while .1 per cent of soap gave 8 per cent. In other words, Zephiran was seven times more efficient than the soap solution. In preoperative preparation there is a kerolytic action, as demonstrated by the detritus that occurs in washing the skin with Zephiran. The emollient action of the skin was evident when a surgical glove was worn on one hand dry, and on the other hand wet, with 1:5,000 Zephiran solution. The hand wet by the Zephiran solution was soft and smooth and remained so for several hours after the skin was dry.

In addition to the important cleansing ability of this substance, Zephiran, like the other quaternary ammonium salts, possesses high bactericidal and bacterio-

his associates. They used bacteria in various media and to show that the disinfectant did not act on the culture media they used the suspension method as well as the bacterial carrier method. They recognized the importance of the difference in virulence of various bacteria. They found that in dealing with highly virulent *Bacillus coli* and staphylococcus, 1:200 dilution of Zephiran was required to get a germicidal effect in two and one half minutes, but with the ordinary run of bacteria they were able to get the same effect with a dilution of 1:2,500. To obtain the same effect with creosol solution dilutions of 1:100 were required. Against gram-positive staphylococcus, streptococcus and pneumococcus, the two and one-half minute effect was

aqueous solution to cleanse chronic ulcers, osteomyelitic wounds and infected compound fractures with excellent results. We have found it a convenient and safe antiseptic in cleansing wounds in minor surgery, convenient since it saves time.

#### SUMMARY

We wished to establish the value, if any, of the cationic detergents as antiseptics. We found that the primary value of alkyl dimethyl benzyl ammonium chloride, one of the cationic detergents, was its cleansing effect. Experiments seemed to confirm the findings of others, that it has a high bactericidal and bacteriostatic effect. Our clinical experiments showed that it can be safely used as a preoperative cleansing material for the surgeon's hands, as well as the operative field. We found it satisfactory for cleansing wounds in minor surgery. We have used it in cleansing infected wounds without signs of irritation to tissue. After using it over a year, we believe that alkyl dimethyl benzyl ammonium chloride, one of the cationic detergents, is a rapid, safe and effective surgical antiseptic.

#### PREOPERATIVE PREPARATION OF THE HANDS ZEPHIRAN—1 MINUTE

Meagre growth: 1-5 colonies

Moderate growth: 6-20 colonies

Heavy growth: Above 20 colonies. All 48 hours

1. J. S. Negative	11. W. C. Negative
2. W. C. Negative	12. D. K. Negative
3. D. K. Negative	13. D. K. Negative
4. J. S. Negative	14. B. S. Meagre hemolytic Staphylococcus Albus
5. W. C. Negative	15. W. C. Negative
6. D. K. Negative	16. H. S. Negative
7. H. S. Negative	17. D. K. Negative
8. W. C. Negative	18. B. S. Negative
9. J. S. Negative	19. H. S. Negative
10. D. K. Negative	20. W. C. Negative
20 Experiments: 1 (5%) Positive Culture	
19 (95%) Negative Cultures	

#### PREOPERATIVE PREPARATION OF THE HANDS SOAP AND WATER—10 MINUTES—AND ALCOHOL

Meagre growth: 1-5 colonies

Moderate growth: 6-20 colonies

Heavy growth: Above 20 colonies. All 48 hours

1. D. K. Meagre	Hemolytic and non-hemolytic Staphylococcus albus
2. H. S. Moderate	Hemolytic Staphylococcus albus

3. J. S. Moderate	Hemolytic Staphylococcus aureus and albus
4. D. K. Negative	
5. H. S. Moderate	Hemolytic Staphylococcus albus
6. W. C. Meagre	Hemolytic Staphylococcus albus
7. J. S. Moderate	Hemolytic Staphylococcus aureus and albus
8. D. K. Negative	
9. H. S. Moderate	Hemolytic and non-hemolytic Staphylococcus albus
10. W. C. Negative	
11. B. S. Moderate	Hemolytic Staphylococcus albus
12. H. S. Heavy	Hemolytic Staphylococcus albus and aureus
13. W. C. Meagre	Hemolytic Staphylococcus albus
14. H. S. Meagre	Hemolytic Staphylococcus albus
15. D. K. Negative	
16. B. S. Negative	
17. W. C. Moderate	Hemolytic Staphylococcus aureus and albus
18. H. S. Moderate	Hemolytic Staphylococcus albus
19. B. S. Meagre	Hemolytic Staphylococcus albus
20. D. K. Moderate	Hemolytic Staphylococcus aureus and albus
20 Experiments	15 (75%) Positive Cultures 5 (25%) Negative Cultures

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cultures of each method were taken. There were five persons included in the experiment with constant alternating of cleansing between the Zephiran chloride and the soap, water and alcohol. Two controls of each performer were taken. All of the experiments were carried out on our surgical floor in order to imitate actual conditions in preoperative preparation of the hands: caps, masks and scrub suits were donned; sterile brushes, sterile containers for the Zephiran, alcohol and sterile water were employed, as well as sterile towels for the drying of the hands.

The charts and graphs show our results. (Figs. 2 and 3.) All controls, of course, showed positive cultures; the usual manner of scrubbing with soap and water with alcohol and sterile water soaks showed 75 per cent positive cultures, and the cultures of the Zephiran chloride preparation showed 5 per cent positive cultures (one in twenty cultures). The speed of action of this coconut oil derivative is effectively shown in Figure 2, while Figure 3 shows the number of colonies in each culture.

The value of any bactericide is definitely limited by any toxic effect or irritation that it may cause to tissue. The toxic and irritative effects have been studied repeatedly. The fact that the skin is not irritated in concentrations that will act as antiseptics has been demonstrated in our experiments with the washing of the hands and in skin preoperative preparation. Experimental studies were carried out by injecting 1:2000 solution of the Zephiran (benzyl-trialkylammonium chloride) into the ear and into the peritoneal cavity of rabbits, and no irritation was found, nor were any toxic effects observed.<sup>4</sup> Prolonged oral administration of potable solutions of ammonium chloride preparation were well tolerated and daily intraperitoneal injections of dilute solutions in the guinea pig gave no deleterious effects. Installations of drops in the human eye of dilutions suitable for effective use as a bactericide produced minimal subjective symptoms.<sup>9</sup>

The skin in various regions of the body, as well as the mucous membranes in the orifices, showed no signs of irritation after being washed with 1:1,000 dilutions of ammonium chloride preparation.<sup>10</sup>

We have found that repeated use by several members of the hospital staff have at no time given any irritating effect; others have found similar results, notably Dunn.<sup>9</sup> We found two instances on record of surgeons who could not use soap and water scrubs without getting dermatitis, who found they were able to get surgical preparation of their hands with the quaternary ammonium chloride solution without any signs of irritation. The germicidal effect for the quaternary ammonium chloride is within the range of 1 to 3,000, which is non-irritating for mucous membranes and apparently, as far as we could establish, non-irritating for vital tissue. We have been able to wash wounds with a 1:3,000 solution without irritating effect and with evidence of an antiseptic effect. The infection cleared up and healing took place. It is difficult to make comparative studies. In our opinion, Zephiran 1:3,000 is an excellent substance for cleansing infected wounds, and compares favorably with the use of soap and water. In a series of seventy-six cases reported by White, Collins and Newman,<sup>8</sup> ammonium chloride detergent was used as a germicide for preoperative preparation, and infection occurred in one case, or 1.3 per cent, whereas a comparative study of twenty-five cases in which 3.5 per cent of tincture of iodine was used as a disinfectant showed there were seven infected cases. We have used alkyl dimethyl benzyl ammonium chloride in solution of 1:1,000 as a routine preparation of the skin in orthopedic procedures, including surgery for internal derangements of the knee, hallux valgus and reconstruction operations, without infections. The skin was washed with the aqueous solution for at least two minutes and a tincture containing a stain was used to delineate the operative field. We have used 1:3,000

# THE NEW COAGULUM-CONTACT METHOD OF SKIN GRAFTING\*

FURTHER SIMPLIFICATIONS IN TECHNIC

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A NEW physiological method of skin grafting based on the principles used in tissue culture has been developed during the past fourteen months. A preliminary report of experiments on rats in which heparinized autogenous plasma and cell extract from the buffy coat alone, (or from the buffy coat admixed with erythrocytes) have been used as a means of promoting the immediate fixation of the graft and subsequent union by stimulation of cellular growth has previously been presented.<sup>1</sup> When grafts are applied after heparinized autogenous plasma has been painted on the recipient area and cellular extract on the under-surface of the graft, a coagulum forms within a few minutes which fastens the graft in place, rendering unnecessary either sutures or special retention dressings. As a rule, vascularization of the graft follows within forty-eight hours. In the original technic, the animal's blood was centrifuged, the plasma separated and the cell extract made immediately before the grafting was undertaken. These technical procedures, simple as they are, offer certain difficulties in clinical application so the technic has been modified in the further animal experiments being reported in this paper, using guinea pigs instead of rats.

A number of guinea pigs are bled from the heart (using 1 cc. of a 0.1 per cent heparin solution to 5 cc. of blood to prevent clotting), the blood immediately centrifuged and the plasma pooled. One and a half cc. of the pooled plasma are transferred to 5 cc. vaccine vials and dried.\*

\* We wish to acknowledge our indebtedness to Dr. John Henderson, of Sharp & Dohme, who has co-operated in the drying of the plasma.

Similarly, 1.5 cc. of the buffy coat suspension to which many erythrocytes may adhere are placed in cotton-stoppered vials and permitted to dry spontaneously in the refrigerator. After drying, the vials are sealed with rubber stoppers and covered with celloidin. This dried material remains potent either at room temperature or in a refrigerator for at least two months. Before use, the desiccated plasma and the buffy coat are each dissolved in 1 cc. of sterile distilled water. The plasma is dissolved with as little agitation of the vial as possible while the desiccated buffy coat is vigorously shaken. Small particles of the undissolved buffy coat material do not prevent successful grafting.

The usual preliminary requirements for any successful grafting are desirable. The surface to be grafted should be clean and free of necrotic tissue. If the recipient area has been denuded immediately before grafting, all the bleeding vessels must be tied with silk sutures. On animals hot saline compresses are usually sufficient to stop bleeding. After the recipient area has been prepared, the donor area is shaved and washed with soap. The size of the graft is then outlined by cutting a piece of cellophane the required size and shape; the thickness of the skin graft depends on the end results desired. Thin, medium and thick split grafts as well as full thickness grafts may all be used successfully with the method. The graft is placed denuded side up on sterile gauze without rinsing or wetting the graft with physiological saline as it washes out the desirable autogenous cell juices which aid in promoting the formation of the clot and cell

\* From the Department of Pathology, Temple University Hospital and School of Medicine, Philadelphia.

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BECAUSE the larynx is composed of cartilages covered with soft tissues, some closely related to the supporting structures, and others separated from it by considerable loose areolar tissue, the reaction of the laryngeal tissues to injury by the tubercle bacillus is quite different than that of the lung.

From "Tuberculosis of the Ear, Nose, and Throat," by Mervin C. Myerson (Charles C. Thomas).

# BURN THERAPY

## CONSIDERATION OF BURNS IN INDUSTRY

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THE expansion of industry due to the war effort has given greater significance to the consideration of burn therapy. First, the percentage of industrial burns is higher; second, there are fewer available industrial physicians. It is the duty, therefore, of all physicians to obtain adequate training in the treatment of burns in order to fill the needs of industry and of civilian practice.

The best estimates available from fire insurance companies indicate that approximately 10,000 lives are lost each year as a result of burns or accidents directly or indirectly due to fires. In 1937, the Census Bureau reported 1,688 persons killed in conflagrations, and 6,240 persons who lost their lives due to accidental burns of which 774 fatalities took place in automobiles. An interesting fact is that almost half of all fire deaths involve children under fifteen years of age or persons over seventy. Nearly twice as many girls of five to fourteen were burned to death as were boys of the same age, which may be interpreted as evidence of the inflammability of girls' clothing.

In 1941, statistics reported 7,800 deaths from burns of all types throughout the United States.

In the State of Pennsylvania alone, the first nine months of 1941 showed 5,026 burns and scalds reported to the National Safety Council. This is an average of about 558 burns per month in industry. In 1942, the average rose to 599, an increase of forty-one burns per month. Burns and scalds accounted for 4.5 per cent of all industrial accidents in Pennsylvania.

### CLASSIFICATION

The etiological classification of burns is familiar to us all as: thermal, chemical, ultraviolet, electric, x-ray and radium.

Pathologically, burns are divided into first, second and third degree, depending upon the depth of skin damage. Obviously, this is a gross division for it is apparent that this classification offers no sound basis for the treatment of burns, because burns of any degree present special problems dependent upon the location, surface area and type of tissue involved. It follows that burns of the third degree offer the complicating factor of depth of penetration since the treatment may vary depending upon the amount of fascia, tendons, muscles or bones destroyed.

It is common opinion that burns of the first degree will usually prove fatal when two-thirds of the body surface is involved, and that burns of one-third of the body surface offer a poor prognosis and may also prove fatal. All burns affecting one-tenth or more of the body surface must be looked upon as serious and ideally should be hospitalized for adequate treatment.

In the estimation of the burn area involved, the chart worked out by Berkow is a useful table and helps determine the prognosis of the burned individual. (Fig. 1.)

The only distinction we make between burns and scalds is to note that moist heat, above a temperature of 125°F., will produce a scald, while dry heat of a temperature of 140°F. or above, will produce a burn. Boiling water or other liquids, superheated steam and molten metals produce scalds. Molten metals



growth. A thin layer of the plasma is brushed on the recipient area. In the same way the cell extract is painted on the underside of the graft. The graft is then quickly turned and fitted into place with delicate forceps. The guinea pig, which up to this point has been under ether anesthesia, is then given 0.2 cc. of nembutal intramuscularly to keep it quiet for a few hours. The coagulum "sets" in five to ten minutes.

In animals, in order to avoid contamination of the field and removal of the graft by clawing or biting, a protective dressing of boric acid ointment is placed over the graft. This is held in position by a cork ring and a binder having two openings for the forelegs. This binder is then sewed snugly together over the back of the animal. Either the chest or back may be used for grafting but we have found the back more satisfactory for the guinea pig. As in the previous experiments on rats, vascularization of the graft was usually well established within forty-eight hours.

Grafting with autogenous plasma and cell extract has been successful in a series of ten human cases using both thin split skin and full thickness grafts. A trial of

this modified technic using pooled dried plasma and cell extract is in progress and the results will be reported in detail later.<sup>2</sup>

#### SUMMARY

1. Pooled, heparinized dried plasma and dried cell extract have been used instead of fresh autogenous plasma and cell extract in experimental skin grafting in guinea pigs.
2. A discussion of the principles and technic is presented.
3. The method obviates the necessity of stitches, dressings or other protective measures.
4. The method has all the advantages of the previously described method plus the convenience of having the plasma and cell extract immediately available for use anywhere at any time.

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of the hyperpermeable capillaries, must be replaced by plasma, and such replacement should occur within the first six hours. Only when plasma is not available should other fluids be used for infusion purposes. In such instances saline solution, plus 5 per cent glucose, may be of temporary value in building up the circulatory volume; but the benefit to be derived is necessarily transient, since the added fluid is rapidly lost through the hyperpermeable capillary walls. Transfusions of whole blood possess the disadvantage that while they will restore the blood volume in some measure, they aggravate the existing hemoconcentration. As a general rule, whole blood should be given only in the early treatment of burns when actual hemorrhage has occurred, or in the treatment of the anemia which develops about the fifth or sixth day, or weeks later. (Table 1.)

TABLE 1

MINI-MONIC SUMMARY OF BURN SHOCK

- S. *Seepage* through the capillaries following capillary dilatation, with loss of plasma.
- H. *Hemoconcentration* with decrease of blood volume and blood flow, and increase in hematocrit and hemoglobin.
- O. *Oxygen want* or *anoxemia* of the tissues.
- C. *Cardiac output decreased* because of loss of plasma by seepage into the tissues.
- Na. *Sodium salt increase* with decrease of sodium chloride and proteins.

Hemoconcentration is the most important clinical and prognostic sign of shock in uncomplicated burns.

\* From Hartline: "Treatment of Burns" (reprinted by Charles C. Thomas).

#### SUMMARY OF NATURE OF BURN SHOCK

With severe shock, administration of oxygen and of suprarenal cortical hormone is helpful. Cortical extract in adequate dosage is believed to decrease capillary permeability, thus shortening the period during which protein leaks through the capillaries, and cutting down the loss of plasma, sodium and chloride. If possible, fluid should be administered by mouth, but reliance should not be placed upon this for replacement of plasma loss.

The plasma should be given in divided doses, approximately 500 cc. at a time.

Subsequent clinical treatment of plasma loss is determined on the basis of hematocrit readings, as suggested in Table 2.

TABLE 2

CLINICAL TREATMENT OF PLASMA LOSS

General rule: In the early stages of shock, when the hematocrit is high, plasma should be given. In the late stages, when the hematocrit is low, plasma should be given. In the intermediate stages, when the hematocrit is normal, plasma should be given if the patient is in shock.

1. Give 500 cc. of plasma if the hematocrit is above 45.
2. Give 100 cc. of plasma if the hematocrit is above 40.
3. Give 50 cc. of plasma if the hematocrit is above 35.
4. Give 25 cc. of plasma if the hematocrit is above 30.
5. Give 12.5 cc. of plasma if the hematocrit is above 25.
6. Give 6.25 cc. of plasma if the hematocrit is above 20.
7. Give 3.125 cc. of plasma if the hematocrit is above 15.
8. Give 1.5625 cc. of plasma if the hematocrit is above 10.
9. Give 0.78125 cc. of plasma if the hematocrit is above 5.
10. Give 0.390625 cc. of plasma if the hematocrit is above 0.

#### WOUNDS

The keynote of local burn therapy we believe to be the conversion of the open, contaminated burn surface into a clean wound. For mechanical cleansing, we advocate the use of sterile washbaths, and insist that the surgeon and assistant use aseptic technic as carefully as with any major surgery. Admitting that all burns are contaminated wounds, we believe that infection can be prevented in burns if the patient is seen promptly after injury and has not received extensive or prolonged first-aid.

#### DEBRIDEMENT

Reference to this procedure in deep or dirty burns has been aptly called a two-edged sword. Conservative surgeons hesitate to remove all apparently dead skin because of the danger of removing viable islands of skin. Radical surgeons remove all dead or necrotic skin and believe that in so doing they spare the patient the intoxication from its absorption, to speed healing. Debridement, therefore, should be used only after careful and, most of all, with extreme caution.

One word about the importance of mixed bacteria and a quick test for the burned areas is not amiss, for it has been repeatedly emphasized by experiment, in war and industrial disasters, that severe burns merit the same early and prolonged

are also known to produce second and third degree burns. Fluids, such as oil, which boil at higher temperatures than water produce increasingly severe burns. Since the heat of solid bodies is usually greater than that of liquids, the former will produce very deep burns, while liquids flowing over a large surface will cause more extensive, though comparatively superficial lesions. The pathology and treatment of burns and scalds is relatively the same.

#### GENERAL CONSIDERATIONS OF THE BURN PROBLEM

Obviously, the clinical picture of a burn depends chiefly on the extent of the surface involved. Minor burns cause only local reaction and require only local treatment. Extensive burns result in general reactions, the most important development being recognized as shock.

In the treatment of extensive burns, the surgical principles involved are the same regardless of the type of burn we are dealing with. The aims of the physician appear to be threefold: (1) Prevent and combat shock; (2) convert the open, contaminated wound into a clean wound, and (3) cover the open wound with the simplest possible protective dressing.

#### MANAGEMENT OF BURN SHOCK

It is well recognized in the treatment of burns that first efforts should be directed toward the prevention or limitation of shock, and therefore there should be no *local treatment* before resuscitation of the patient. In all cases of severe burns, the patient sustains some degree of shock, and according to the severity of the condition, manifests some or all of the symptoms. It is now well understood that shock following burns is different from traumatic or hemorrhagic shock. The cardinal feature of burn shock is the *loss of plasma* both from the burned surface and by exudation from the capillaries into the surrounding tissues. This loss commences early (within two hours) and is progressive in character.

Diminution of blood volume with lowering of the blood pressure, hemoconcentration, and increased viscosity of the blood are natural results of this phenomenon. As Blalock<sup>15</sup> has shown, there is a marked shift of plasma fluid from the intravascular to the extravascular spaces, resulting in an acute loss of circulating blood volume.

#### GRAPHIC DESCRIPTION OF SHOCK

Observers agree that primary shock can be severe and is not necessarily dependent upon the extent of the area burned. For this *primary shock*, morphine is an aid. For an adult,  $\frac{1}{4}$  gr. dose is the usual requirement for relief of pain and fright. Secondary shock is due to loss of body fluids from burned surfaces, and still more important, loss of fluids into subcutaneous tissues. The latter is comparable to the bleeding that occurs into a crushed limb; and it is this secondary shock with which we are so vitally concerned. *Experimentally, it is estimated that half of the fluid shift occurs within the first six hours.* Authorities now consider the external application of heat undesirable on the basis that the resultant cutaneous vasodilatation causes a peripheral pooling of blood, decreasing venous return, thus contributing to further circulatory collapse. In burn cases, therefore, we strive to maintain the body temperature within physiological limits.

Elkington,<sup>26</sup> Wolff and Lee, of Philadelphia, reported a 20 per cent loss of body plasma volume within fifteen minutes of the occurrence of a second and third degree burn of 20 per cent body surface. It is evident, therefore, that just as in the early surgical repair of ruptured peptic ulcer we must attempt to replace plasma loss in severe burns within those first six golden hours.

The most pressing need in such cases is for dilution of the blood with a fluid which will not readily pass into the tissue spaces, and plasma constitutes the ideal physiological medium. In other words, the plasma which has literally run out

shortens the period of eschar formation. (Fig. 2.)

*Gentian Violet.* A 1 per cent solution is

sterile sheets, in a heated, tented bed, and the burns compressed with thick layers of gauze soaked in physiological saline. Pre-

#### BERKOW'S METHOD OF ESTIMATING THE EXTENSIVENESS OF SURFACE LESIONS

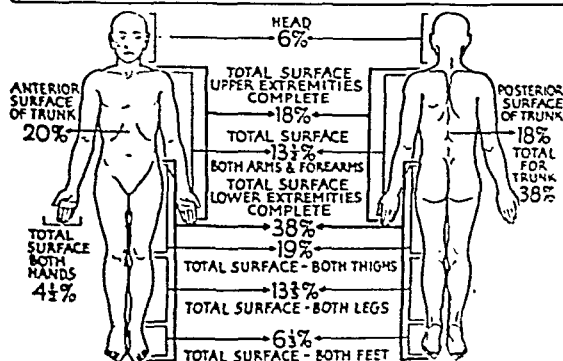


FIG. 1. Berkow's chart. (Reproduced by courtesy of W. B. Saunders & Co.)

of particular value in superficial thermal injuries showing evidence of infection when first seen, or in burns of more than forty hours' duration. It is especially useful in burns of the hands, feet, perineum, and deep burns encircling extremities in the region of joints. The antiseptic property of gentian violet seems to be enhanced by the combination with silver nitrate, and a thin, dry, pliable eschar results. (Fig. 3.)

*Triple Dye Method.* Aldrich<sup>3</sup> advocates this method, where as fast as one coating dries, another is applied until a definite eschar is formed, which resembles a piece of purple leather with a gold, green sheen, and affords a more complete antiseptic action with mild powers of escharosis. Theoretically, this combination of dyes is specific against both gram-positive and gram-negative organisms, and when exposed to the air relative sterility should be easily maintained. We find this method desirable with burns of genitalia, hands, and encircling burns about the joints.

*Saline Bath Treatment.* English clinicians favor the saline bath treatment for severe or extensive burns. Here the patient is kept slung in a saline solution bath which is maintained thermostatically at body temperature for one to six hours or longer. The patient is then placed on



FIG. 2. E. H. Example of tannic acid therapy on second and third degree burns of 33 per cent of body surface.

liminary covering of the burned area with tulle grass, over which the saline dressing is laid, offers certain advantages. The dressings should remain wet or pain will ensue. For burns about the joints, frequent immersions are beneficial. In burns of the face, a mask kept wet with saline should be worn, while eyelids and hairy areas should be smeared with sterile vaseline.

*Pressure Treatment.* Dr. Koch<sup>36</sup> advises this simple, but effective treatment. Following *débridement*, the burned wound is covered with strips of vaseline gauze and pressure is applied by means of fluffed gauze or mechanic's waste held in place by elastic bandages or stockinet. This dressing is not disturbed for ten or twelve days, and when removed, first degree burns will be found to have healed. Any necrotic portions of skin are then excised and skin grafting follows. This method offers the advantage of a minimum change of dressings and nursing care. It was used ad-

immobilization that one would give a compound fracture. Hence military surgeons advocate the use of plaster casts in the transportation of severely burned patients.

#### HEALING OF BURNED SURFACES

In the loss of partial skin thickness, complete regeneration of epithelium takes place in ten, twelve or fourteen days, and healing of the burned area should be complete when the primary dressing is removed. The surgeon must keep in mind that in the loss of whole thickness of skin, no dressing can bring about regeneration of the epithelium; for reformation of covering skin can come only by ingrowth from the periphery or as a result of skin grafting. To await spontaneous healing when a denuded surface is more than two square inches in area, is only to delay recovery. The physician must possess the courage of his convictions and do repeated surgical débridement or skin grafting when the occasion demands.

#### LOCAL TREATMENT OF BURNS

The third consideration in burn therapy, involves covering the wound with the simplest possible protective dressing, in order to accomplish the following: (1) Protect the burn from constant danger of reinfection; (2) not fix or destroy any part of the viable skin or subcutaneous tissue; (3) exert a uniform moderate pressure over the burned surface and provide for the drainage of the exuding serum, until it is checked by pressure or the normal process of coagulation; (4) be easily removable if infection develops underneath the dressing, or if skin grafting is required.

The fact that we have so many types of local burn treatment is evidence of the lack of the complete efficiency of any one of them. Following table lists only a portion of the many burn treatments advocated in recent years. (Table III.)

In small, superficial burns that are

properly cleansed, it makes little difference which method is used locally. Any one of the various tannic acid preparations, antiseptic dyes, or ointment dressings, will give satisfactory results when properly applied.

TABLE III  
LOCAL BURN THERAPY

1. Tannic acid 5%	28. Gadomest
2. Tannic acid jelly	29. Camphorated oil
3. Tannic acid silver nitrate	30. Paraffin
4. Gentian violet 1%	31. Tulle grass
5. Gentian violet silver nitrate	32. Plaster casts
6. Triple dye	33. Dextrose, sucrose solution
7. Ferric chloride	34. Alcohol dressings
8. Tea	35. Bismuth subnitrate gauze
9. Ink	36. Electrosurgical brush
10. Olive oil	37. Sodabicarb. paste
11. Unguentine	38. Zinc oxide and wax paper
12. Mercurochrome	39. Vaseline gauze
13. Brilliant green	40. Foille
14. Acriflavine	41. Saline baths
15. Dichloramin-T	42. Sulfhydryl solution
16. Dakin's solution	43. Bunyan envelopes
17. Amyl-salicylate	44. Pressure dressings
18. Aluminum acetate	45. Sulfanilamide powder
19. Carron oil	46. Sulfathiazole suspension
20. Dry dressings	47. Sulfathiazole ointment
21. Adrenalin packs	48. Sulfadiazone ointment
22. Horse serum	49. Sulfadiazone methylcellulose
23. Picric acid	50. Sulfadiazine film
24. Acetic acid	
25. Débridement	
26. Cod liver oil	
27. Viscopaste	

*Tannic Acid Treatment.* This is still the official method of local therapy for burns and scalds with the British Emergency Medical Services and with our own Naval Forces. It has been used for many years with fairly good results and has stood the test of time. A freshly made 5 per cent tannic acid spray, repeated at 15-minute intervals, will form a satisfactory coagulum although some condemn this slow tanning because of toxic absorption. Tannic acid jellies or pastes of 5 to 10 per cent strength are commercially available and are valuable for office and industrial practice. Tannic acid 5 per cent and silver nitrate 10 per cent combined, make a valuable addition to this type of treatment, and in our experience its value has been demonstrated for it

is cut to fit the burn surface and makes an excellent bacteriocidal first-aid dressing, which seems desirable and appropriate for burns received at the battle front. (Fig. 5.)

Thus a review of modern burn therapy leaves even the experienced surgeon wondering which method of local treatment to select. In an attempt to help clarify this situation the following table is offered (Table IV):

TABLE IV  
CHOICE OF LOCAL BURN THERAPY

Body Portion	First Degree	Second Degree	Second and Third Degree
Face	Vaseline Dressing Sulfadiazine Ointment Triple Dyes	Vaseline Dressing Pressure Treatment (Koch) Saline Packs Sulfadiazine Emulsion*	Vaseline Pressure Treatment Saline Packs
Hands	Boric or Vaseline Paste Dressings Sulfonamide Pastes Dye Therapy	Vaseline Dressings Pressure Treatment Saline Baths	Vaseline & Pressure Dressings Saline Baths
Extremities	Sulfonamide Pastes Triple Dyes Tanning Methods	Pressure Treatment Sulfonamide Pastes Tanning Methods Saline Baths	Pressure Treatment Saline Baths
Trunk	Tannic Acid--Silver Nitrate Sulfadiazine Spray Triple Dyes Vaseline Dressings	Tannic acid and Silver Nitrate* Sulfadiazine Spray Triple Dyes Pressure Dressings	Tannic Acid-Silver Nitrate* Pressure Dressings Saline Baths
Perineum and Genitalia	Boric Ointment Sulfonamide Pastes or Emulsions* Dye Therapy	Sulfonamide Pastes or Emulsions* Saline Baths	Sulfonamide Pastes or Emulsions Saline Baths

\* The treatments indicated by asterisks were recommended by the National Research Council in January, 1942.

TREATMENT OF BURNS IN INDUSTRY

With limited industrial thermal burns in which the area of involvement does not exceed 10 to 15 per cent of the total body surface, and the depth of penetration is not excessive, sterile petrolatum gauze can be utilized following the usual preparation of the area. This is satisfactory especially in burns involving the extremities, and should be fortified with copious gauze dressings snugly applied to exert pressure.

In minor industrial burns it is advisable to use 5 per cent sulfathiazole or sulfadiazine ointment, or a mixture of the two.

Statistics indicate a great preponderance of hand burns in industry and these require special consideration. Hand burns caused by scorching with very hot objects, molten metals, or flames are usually small but deep. Treatment of these patients is generally conservative, and briefly, consists of

cleansing with soap and water, irrigations with boric acid or saline solutions, dry sterile dressings or sulfonamide ointments, followed by properly fitting splints for immobilization. If infection develops, more drastic treatment is required and frequently surgical resection of necrotic tissue is necessary. When the burns are deep and show no tendency to epithelialize, early skin grafting is advised as soon as a clean, granulating surface is obtained.

vantageously on many victims of the Boston "Cocoanut Grove" fire, and appears to be the most desirable local treatment yet evolved. (Fig. 4.)

satisfactorily used 3 per cent sulfadiazine solution in 8 per cent triethanolamine, on 116 burn cases, and has now altered his formula to include methylcellulose which

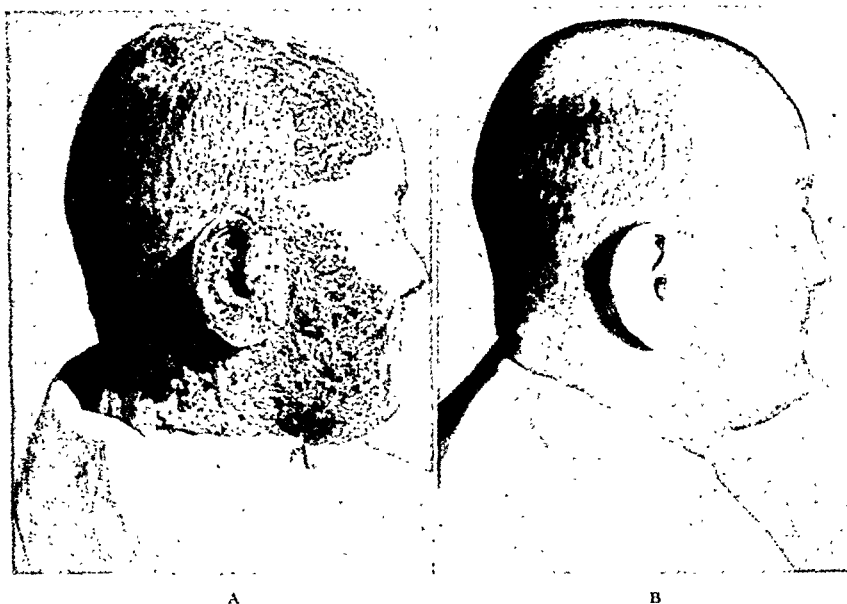


FIG. 3. A, flash burn following ignition of zirconium; treatment with gentian violet and silver nitrate therapy; B, result three weeks later.



FIG. 4. Example of vaseline gauze pressure dressings in extensive burn. Note thickness of dressings deemed necessary.

*Chemotherapy.* Practically every combination of sulfonamides as solutions, suspensions and ointment have been reported by various workers with good results. Sulfanilamide or sulfathiazole, either in powder or microcrystalline form, may be dusted on the burn and followed with pressure dressings kept moist with saline solution. The use of 5 per cent sulfathiazole ointment or emulsion is ideal for burn areas not suitable for tanning. In 1941, Pickrell

is a film-forming compound and has the advantage of forming a rapid, artificial layer resembling cellophane over the burned surface. Apparently there is no toxicity and the film is antiseptic, therapeutic and translucent. We have been pleased with this method of treatment in practically any region except the face. Sulfa-film or sulfanilamide incorporated in cellophane-like tissue, is the newest departure in burn therapy. This pliable film

local treatment, a sterile dressing is applied and the physician must select future therapy with careful judgment, since chemical burns are usually very deep and tend to heal slowly. Convalescent care consists chiefly of the prevention of infection by the application of wet antiseptic dressings or sulfanilamide powder; and when infection is controlled and healthy granulations appear, a properly selected skin graft is desirable.

*Magnesium burns* (molten magnesium) have lately caused considerable concern in industries, for they are prone to form very slow-healing granulomatous ulcers.

Metallic magnesium interferes with normal cell physiology and causes interferences with normal repair processes. Prompt removal of metallic magnesium by excision of burnt skin under local anesthesia is required for healing. A 5 per cent sulfanilamide unguent follows denudation of the area.

#### X-RAY AND RADIUM BURNS

The frequency of these burns among physicians is so well known that no detailed discussion is necessary. Once an x-ray or radium burn is established as a deep ulceration, the problem of treatment is essentially surgical and local application of any single medication should not be carried on too long, for the ever present danger of malignant change needs to be kept in mind. Excision and plastic resuturing can be done with small lesions, while whole thickness or pedicle grafts may be required in the plastic repairs of large, deep x-ray burns.

*Ultraviolet ray burns* are extremely common in the popular sunburn, and respond well to local treatment with boric acid or butesin picrate ointments. Some general treatment may also be required; but sunburns are rarely serious, as they are usually first degree burns. A few ultraviolet light burns have been reported and these are serious, as they cause a large surface damage and are frequently dangerous out of proportion to their depth.

Treatment varies with the judgment and experience of the individual surgeon, with special attention to the general care of the patient.

*Gasoline burns* are notorious in presenting a larger incidence of complications such as cellulitis, lymphangitis, slow healing scars and deep contractures. Statistics show that women are the chief victims of kerosene and cleaning fluid burns, and these require the same general treatment given chemical burns.

*Eye burns* merit special attention. With acid or alkali burns, lids should be held open and irrigated with either a weak neutralizer or copious amounts of cold boric acid or even plain water. A few drops of olive or mineral oil are then dropped into the eye, or a single instillation of 2 per cent butyn ophthalmic ointment. The patient must be warned not to rub the eye, as severe corneal injury may result. If corneal ulceration is suspected, a consulting ophthalmologist should be called. Instillations of atropine for papillary dilatation are often advised. No dressing should be used, and the eye should be flushed free of secretions. In eye burns produced by caustic soda, a neutralizing solution of 5 per cent ammonium chloride has been found to be most effective as an irrigant.

#### CONFLAGRATION TYPE BURNS

These burns tend to be extensive and fatal due to the primary shock and the frequent complications which include laryngeal and pulmonary edema from inhalation of smoke and gases. Autopsies indicate that all persons trapped in a burning atmosphere may inhale hot air, flames or poisonous gases, and must be observed very closely. Hospitalization becomes, therefore, imperative, because of the high incidence of immediate pulmonary complications. These types of burns may produce no skin lesions and yet severe damage to the trachea and lungs may ensue and rapidly cause edema, pneumonia and death.

Concerning any type of burn, when the acute stage is over and the paramount



## ELECTRICAL BURNS

Here there are two factors to be considered: the burn itself and the effect of



FIG. 5. Illustrating the sulfadiazine methyl cellulose treatment of burns. Note the cellophane-like appearance at the edges of the wound.

the electrical current. Actually the amount of local injury is determined by the degree of local contact, which results in: (1) *Electric current mark*; usually circular or elliptical areas, varying in size from a pin-head to a pea; color: grayish white; (2) *electrical necrosis*; this is more severe, more extensive in area than the current mark. The third week is the danger period from severe hemorrhage due to degenerative changes in the artery walls.

When superficial burning complicates electrical necrosis, the clinical picture becomes one of a severe burn with a painful, red area of reaction around the wound, and the patient exhibits the usual toxic signs.

Blood vessels are very good conductors and this may explain the frequency of

thrombosis remote from the place of burn contact. Deep electrical burns are particularly serious and can be called fourth degree in some instances. They may be followed by extensive separation of involved tissues, days or even weeks later. There is also the danger of massive and even fatal hemorrhage. The only treatment for the electric current shock is immediate and continuous artificial respiration. The local treatment of the electrical burn area oscillates between vaseline gauze dressings or early débridement, followed by immediate skin grafting. Antitetanus antitoxin should always be administered, as with any severe burn.

## CHEMICAL BURNS

With these burns, copious amounts of water are applied in great haste to wash off any acid or alkali solutions. The only exception to this rule is in the case of lime burns, which should *not* be treated with water until the excess of lime dust is removed. Obviously, it is important to ascertain the exact nature of the offending chemical so that intelligent treatment may be given.

*Acid burns* should first be neutralized with a mild alkali (5 per cent sodium bicarbonate solution), while alkaline burns may be rinsed with weak acid (vinegar, 3 per cent acetic acid). This should be done before starting any other active treatment, with the caution that damage can be produced by the neutralizing agent itself, when used carelessly. Recently the use of a phosphate solution buffer has been advised to neutralize both acid and alkali burns since it gives a neutral molar solution (ph7) which remains in the physiologic range. Application of this agent is even considered in eye burns, although a transient conjunctivitis may result. Obviously, a more dilute solution of the phosphate buffer will eliminate this hazard but also diminishes the effectiveness of the buffer.

Carbolic acid burns are best neutralized by alcohol and ordinary rubbing alcohol is adequate for this purpose. After this

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issue of preserving the patient's life is settled, the ensuing care of the burn becomes primarily a matter of restoring function and appearance of the part. When a granulating surface presents itself, all efforts should be directed toward making it heal as rapidly as possible without surgical measures. However, when these efforts fail or when the progress of the burn indicates that the natural processes at best will take too long, early plastic treatment of burns is indicated and skin grafting should be resorted to. Here the use of Padgett's<sup>56</sup> dermatone cannot be too highly recommended. We believe that with careful technic, split skin grafts are successful in 80 to 90 per cent of all cases and give very gratifying results.

Finally, the importance of maintaining an adequate diet throughout the lengthy convalescent period of all severe burns must not be overlooked, as the biological factors which influence burn healing are the same as those applicable to wound healing.

#### CONCLUSIONS

1. Statistics reveal an increase in the number of industrial burns.
2. In all severe burns there should be no local treatment before resuscitation of the patient from shock.
3. Burn shock treatment is well standardized and the high points have been outlined.
4. Every burn should be converted from an open, contaminated wound to a clean wound.
5. Concerning the local therapy of burns, no one form of treatment can be considered ideal.
6. The treatment selected, therefore, depends on: (1) Size and location of the burn; (2) type and depth of the burn; (3) amount of the time elapsed since its occurrence; (4) amount of infection present or expected; (5) experience and judgment of the surgeon, and (6) availability of material to be used.
7. Present trends seem to indicate that

the methods of tanning and the use of anti-septic dye technic will soon be abandoned.

8. The methods which seem to have the best chance of surviving at the present are: (1) Pressure dressings with or without the use of vaselized gauze, and (2) chemotherapy.

9. Sulfonamide therapy should be routinely employed in all burn cases of more than slight extent. Sulfadiazine is the drug of choice.

10. In the general care of the patient a high caloric high protein diet *with* adequate vitamin intake is recommended.

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# A METHOD OF TREATING NERVE ENDS IN AMPUTATION STUMPS

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SEVERAL years ago, it became our duty to care for the injured employees of a large railroad. Among these were several patients who complained bitterly of their stumps. One man with an amputation at the lower third of the humerus had had several operations by an excellent neurosurgeon, including repeated excision of nerves, and sympathectomy, but continued to complain of intolerable pain. Leriche, in his monograph on pain, reports many similar cases and suggests various operations on the sympathetic system to relieve this pain.

In his monograph on amputations, Major General Norman T. Kirk discusses the various methods of treating nerves in the amputation stump. His modification of the alcohol injection method has proved satisfactory, but he found that painful neuromas, particularly in the arm, sometimes follow this form of treatment and may require further operative treatment from time to time. Recently he has used the suggestion of Col. W. L. Keller that a cone with the apex upward in the nerve end be burned with a sharp-pointed actual or electric cautery. He reports that sufficient cases have not yet been observed to evaluate results.

In our practice, when the peripheral nerves frequently were injected with absolute alcohol at the time of amputation we noted the growth of neuromas at the site of amputation. These have been very painful and seemed occasionally to contribute to a tendency to develop edema and ulceration at the site of the scar.

Since electric current desiccation of small skin tumors is followed by practically no pain, it occurred to us that desiccation of the peripheral nerves with either a bipolar

or monopolar electric current might give improved results.

This method was used in four cases: two cases of amputation of the leg seven inches below the knee performed for severe crushing injury to the foot and ankle; one re-amputation of a painful slightly ulcerated stump originally amputated seven inches below the knee because of severe trauma to foot and ankle; and one Gritti-Stokes type amputation performed for impending gangrene of foot caused by progressive occlusion of the arteries of the leg in a fifty-five-year old woman, apparently caused by arteriosclerosis. The severed nerve was pulled down and minimal bipolar current, which would dry the nerve to a yellowish, moderately coagulated appearance over an area one-half inch long was used, and the nerve was severed at the middle of this region. Postoperatively these patients had more discomfort than is usually noted after treatment of nerves with absolute alcohol, or severing them without alcohol injection. This consisted of drawing sensations referred to the muscles of the leg, ankle, foot and toes. This usually started two or three days after operation, reached its maximum in three or four days more, and gradually subsided until there was practically no annoying sensation after the elapse of a month to six weeks. None of these patients continued to complain of pain after this time. They seemed unusually comfortable. The time of observation varied from three to six months.

An effort was made to obtain experimental information by desiccating and dividing a large nerve in the hind leg of each of two rabbits, and severing the same nerve in another rabbit with a scalpel. After six weeks the operative site was in-

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# TREATMENT OF THE FRACTURED FEMUR IN CHILDREN\*

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AGE plays an important part in arriving at a decision as to the best type of treatment to be used in fractures of various bones of the body. In treatment of fractures of the femur in children this is particularly true. Several methods are in use, a number of which produce excellent results in the hands of surgeons skilled in their use.

Of the older methods, the Hodgen and the Thomas splint are especially to be noted. These splints may be used in conjunction with overhead or direct traction. With the Thomas splint, countertraction may be carried out by elevation of the foot of the bed. The Bryant vertical traction and the Russell traction seem to be the most popular methods used at the present time. Russell traction is an excellent form of treatment for children and adults alike. It is particularly adaptable to children six to twelve years of age. Bryant's vertical traction, utilizing the weight of the trunk as countertraction, is very popular, especially with children up to five or six years of age. The plaster spica has been used for many years by surgeons, with varying degrees of success. The spica is necessarily used following open reduction and plating.

There are certain disadvantages in treatment of fractures of the femur in children by traction. First, considerable mobility of the fragments will occur especially when used on an active child. Although good alignment may be maintained, proper apposition of the fragments is often difficult. Skin traction may result in various complications if maintained for any length of time. Skeletal traction may be used, especially in the Russell method.

Despite the fact that firm union usually occurs in children even when there is overriding or complete displacement of the ends of the fragments, there are certain procedures which will aid in producing quicker and better end results in the treatment of these fractures. The criteria of a good ultimate end result are firm union, normal alignment, and normal length. To obtain them, complete immobilization is necessary and is readily achieved by a properly applied plaster spica.

Those who have condemned the spica have done so on the grounds that there is a tendency to overriding with angulation of the fragments. In our hands the plaster spica has given unusually good end results.

Use of the spica has definite advantages. It is easily applied, giving proper immobilization following reduction, and it maintains normal bone length. The period of hospitalization is greatly shortened, usually being but one or two days, an important factor in a busy general hospital where rapid turn-over of patients is essential. With the child in a cast, nursing care is greatly simplified. The period of plaster immobilization is usually three to four weeks. The spica is especially adaptable in infants and children up to ten to twelve years of age and whether the fracture be transverse, oblique or comminuted.

Open reduction is never resorted to until all conservative measures have been exhausted and satisfactory reduction not obtained. Arguments against plating are: union is delayed; there is the danger of infection and trauma to the soft parts; the period of treatment is prolonged, particularly if the plate is removed later. When open reduction does become neces-

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† Dr. Bush is now a Major on active duty.

spected. In two cases there was a diffuse, or ribbon, fan-shaped, out-growth of the nerve and about one-half inch long. In the third rabbit, the nerve had been severed with a scalpel without desiccation. Here there was a small bulbous area with a cord-shaped out-growth from the tip about one-fourth inch long.

These specimens were studied by a pathologist but, unfortunately, the report and specimens apparently have been lost, due to confusion incident to closing our office.

While the experimental and clinical background for this work have been inadequate and inconclusive, the clinical results

were promising enough to suggest that it be given further trial. Inasmuch as there will certainly be many painful amputation stumps resulting from the war, anything which carries any possibility of lessening this number deserves further study. The advantage of this method seems due to the uniform dessication of the nerve, no matter how small. So often alcohol cannot be successfully injected because the nerve consists of several bundles without a firm outside sheath to cause the alcohol to diffuse evenly and remain in contact with the nerve fibers. It is hoped that neuromas do not form when this method is used.



THE ligaments on all sides of the knee are so strong that complete dislocation is rare. Partial displacement or subluxation may accompany severe sprains. When dislocation does occur it is produced by extreme force applied anteriorly or posteriorly, which tears the crucial, lateral and capsular ligaments.

From "Fractures and Dislocations for Practitioners," by Edwin O. Geckeler (The Williams & Wilkins Company).

maintained with the thigh flexed 15 to 25 degrees at the hip and the knee flexed at right angles. A tight cylinder of plaster

During the past six years we have treated thirty-nine fractured femurs in children. The patients have ranged in age



FIG. 4. Anterior view of cast immobilizing fractured right femur.

is then applied around the fractured thigh. While it is drying the body and opposite leg are encased and both groins are reinforced with plaster strips. A cross bar (thigh to thigh) is incorporated to add strength to the cast and to aid in the after care and handling of the patient. The knee and lower leg are then encased in a thinly padded cast, constant traction being maintained at the knee throughout the procedure and until the cast is dry. With the double spica on the thighs and the knee at right angles the normal bone length and alignment are maintained.

By flexing the thigh at the proper angle and the knee kept at right angles, the muscles are in a position of relaxation. Bed care is then as simple as with any other type of cast. Patients treated in this manner have been uniformly comfortable throughout the period of three to four weeks of immobilization. (Figs. 3 and 4.)



FIG. 5. Shows the spica as applied for bilateral fractures of the middle third of the femur.

from three months to thirteen years. There were three deaths, all occurring shortly after admission to the hospital and due to extensive injuries. With seven patients an open reduction and plating was necessary. But two such procedures have been necessary in the past five years since we have utilized the described cast. In both instances the fractures involved the upper one-third of the femur.

Twenty patients were treated by immediate reduction and application of the spica. Ten were treated by temporary traction (while shock and other conditions were cared for) followed by application of the cast.

Two patients were treated in the dispensary, without being hospitalized. As a general rule, it is advisable to observe the patient in the cast for at least twenty-four hours, in the meantime having the necessary x-ray examinations made before discharging the patient from the hospital.



sary we believe the plate should invariably be removed as soon as firm union has taken place.

for children. It provides quick and complete anesthesia, is safe, there is minimal nausea and vomiting and the patient re-

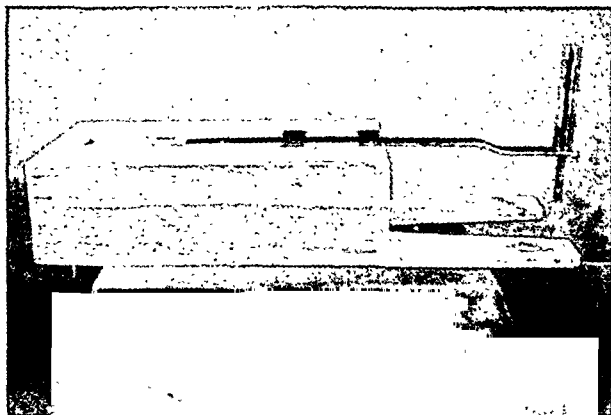


FIG. 1.

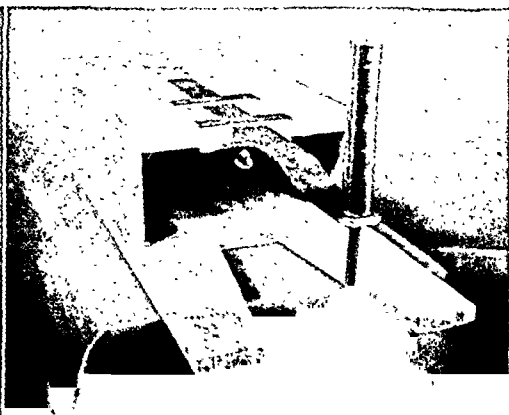


FIG. 2.

FIGS. 1 AND 2. These pictures illustrate a simple adjustable fracture box which may be clamped onto any table.

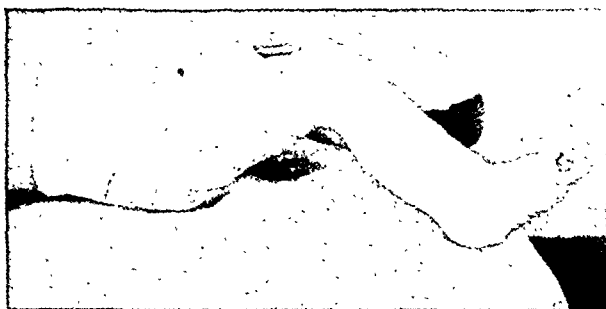


FIG. 3. Lateral view of spica showing angles of flexion used at hip and knee.

Displacement of the short upper fragment by muscle pull in fractures of the upper one-third of the femur often necessitates open reduction. Compound fractures frequently call for plating. Wounds associated with compound fractures are thoroughly débrided and treated with free applications of sulfanilamide. Where small puncture wounds result from compound fractures, they may be properly cared for, the fracture reduced and if the problem is simple a plaster spica applied.

To manipulate and properly reduce a fracture, complete relaxation of the patient is necessary. Ether is probably the best general anesthetic for this purpose. It may be administered by the open drop method or in conjunction with one of the gases. Vinethene is an excellent anesthetic

covers rapidly. Vinethene is irritating to mucous membranes and, therefore, should not be used in the presence of active respiratory infections. Occasionally, the fluoroscope will greatly facilitate the reduction.

The spica may be applied by placing the patient on a simple fracture box (Figs. 1 and 2) or on any of the modern fracture tables.

#### APPLICATION OF SPICA

Under deep anesthesia and with counter-traction at the perineal post of the fracture box or table the spica is applied. The bony prominences (anterior superior spines of the ileum, and sacrum especially) are padded. The leg is manipulated while traction is maintained on the opposite limb. The traction upon the fractured femur is

# CASTILIAN MALVA

CAPTAIN M. MARKS

MEDICAL CORPS, ARMY OF THE UNITED STATES

WHILE investigating plants used in folklore medicine, Thomas<sup>1</sup> became especially interested in the therapeutic and pharmacological action of a weed commonly found in the southwestern part of the United States. It is a low growing shrub of the mallow family and is known as *Malva parviflora* L., also called "running mallow." The bruised leaves and bark have long been used to heal a large variety of wounds. Thomas found that an alcoholic infusion of the whole plant, at low temperature, extracted a stable resin which produced rapid vascular dilation and an increase in the healing rate of injured tissue to which it was applied. His work dealt with the action of the resin in infectious, necrotic, and gangrenous lesions; and except in certain cases with vascular impairment, his results were uniformly good.

The purpose of this study\* is to investigate further the properties of this plant extract, particularly in the field of proctology where surgical wounds are constantly bathed with pathogenic organisms that frequently protract the healing period.

Types of Wounds Treated	No. of Cases
Pilonidal sinuses, open type of operation.....	25
Abdominoperineal resection.....	7
Abdominal wound rupture.....	4
Pruritis ani.....	56
Hemorrhoids—postoperative.....	125
Fistula-in-ano—postoperative.....	18
Pyodermia.....	2
Perianal psoriasis.....	3
Rectal abscess.....	15
Potanal fissure.....	28
Post-proctotomy for anal stricture.....	6
Perianal chemical burns.....	12
Total.....	303

## CLINICAL OBSERVATIONS

The prepared tincture in the dilution suggested by Thomas of 1:50 was first

\* The material for study has been supplied by Upjohn and Company.

employed by irrigation and wet packs. On a freshly denuded surface its use results in marked increase in capillary bleeding. There is also a sensation of warmth and frequently smarting that persists for several minutes. The broken surface slowly becomes diffused with a deeper redness that includes the margins of the wound.

In older lesions an excess of transudate appears; droplets of serum exude which prove microscopically to contain many phagocytes and much tissue debris. Liquefaction of necrotic material is grossly evident at the end of the first hour, at which time the maximum effect of the medication is reached. Within twelve hours the raw surface appears roughened and under a hand lens tufts of rapidly proliferating granulation tissue are visible. When the solution is stopped the hyperemia slowly subsides. At the same time the lymphagogue action and the cellular activity become proportionately less. In none of the cases was there evidence of local or systemic toxicity. The only adverse finding was a sensation of burning experienced by hypersensitive individuals. In these a weaker concentration such as 1:100 could be well tolerated. In others, solutions with a dilution as high as 1:25 produced no ill effects even following constant application for days.

Castilian malva solution produces the described physiological response in wounds having a neutral or slightly alkaline content. When the hydrogen ion concentration falls below 6.2 the resin becomes inert. Thomas discovered that fermentation and the resultant acidulation in aqueous infusions of the plant rendered the resin useless. To study this further I used Castilian malva to irrigate superpubic and other wound of the urinary tract. No therapeutic response was seen until the urine was alkalinized. Two cases of proved peptic

On the average, children treated by spica alone in our clinic were bearing weight by the fifth to the seventh week.

#### CONCLUSIONS

1. A simple method has been described for the care of fractured femurs in children.

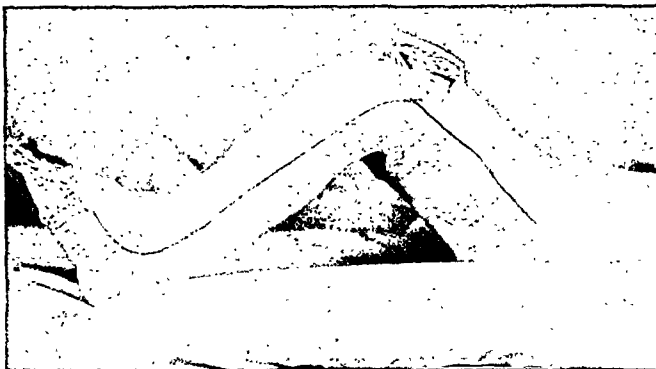


FIG. 6. Lateral view of cast utilized in fracture of both femurs.



FIG. 7. X-ray illustrates the position and alignment as obtained by the cast in bilateral fractured femurs.

The casts were usually removed by the end of the fourth week.

Those fractures requiring plating naturally rendered a longer period of disability, particularly was this so when the plate was removed.

The end results with the thirty-six patients so treated, as judged from follow-up studies, were excellent for the entire group.

The treatment of bilateral fractures of the femur is illustrated in Figures 5, 6 and 7.

2. The advantages of the method over other forms of traction are: (1) shorter period of hospitalization; (2) ease of care of the patient; (3) it may be used in infants or children up to ten or twelve years of age; (4) there is no pressure, infection or necrosis of tissue as occasionally occurs with continued skin or other forms of traction; (5) the child is comfortably immobilized, and (6) universally good results have been obtained as evidenced by early union, normal alignment and bone length and, finally good function.

It has no bacteriostatic nor bacteriocidal effect.

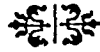
Its physiological effect seems to be due to its vasodilating action.

Its use increases the rate of normal physiological tissue repair.

Incorporation of the tincture in a water-soluble base facilitates its use. These findings confirm those of Thomas.

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*The larynx which has healed after tuberculous involvement cannot be considered cured; it may be considered healed, arrested, latent or apparently cured. The disease in every tuberculous larynx which has healed can become reactivated. With very few exceptions, the healed larynx indicates that the lung is also healed.*

From "Tuberculosis of the Ear, Nose, and Throat," by Mervin C. Myerson (Charles C. Thomas).

ulcer were also treated by incorporating 2 per cent of the tincture in a bland, neutral syrup. Two teaspoonsful were taken before meals and although well tolerated at the end of two weeks there were no appreciable changes in the subjective symptoms or in the x-ray findings.

To facilitate the application of the medication Thomas suggested the use of a jelly as a vehicle. By incorporating the tincture in a neutral, water-soluble base in the concentration of 2 per cent, I obtained a still more practical method of utilization which facilitated dressings in ambulant patients and also permitted more constant contact of the medicament in cavities.

Healing was more rapid in deep wounds such as follow perineal resection, pilonidal sinuses, evisceration with delayed healing of the abdominal wall, postoperative fistula, posterior proctotomy, and incised perirectal or pelvirectal abscesses. These, once good drainage was established and under the stimulation of the resin, rapidly became clean, lost their offensive odor, filled with firm healthy granulation tissue and healed with soft pliable scar. This accelerated healing was further demonstrated on superficially injured skin as in burns and in pruritis ani. In these chemical, thermal, or onychial trauma along with the irritation of the stool may be severely annoying. By its vasodilating action the quantity of circulating blood is markedly increased in the injured parts. Re-epithelization and softening of the inelastic, acanthotic, and macerated skin are noticeable within twenty-four hours and as healing progresses the itching becomes less. In the postoperative care of anorectal wounds the ointment may be applied with the gloved finger or by means of the pile pipe. In the open type of hemorrhoid operation the average healing period is from fifteen to twenty-one days. With the use of Castilian malva convalescence is reduced to ten to fifteen days. Since healing is more rapid, pain and tenesmus is greatly diminished and the resultant scars are softer with less tendency to latent fis-

suring. The presence of bacteria in no way alters the action of the medication. As the drainage from these wounds increases it becomes less irritating. The number of organisms are reduced apparently due to the increased volume of the lymph and the greater number of phagocytes present.

#### COMMENT

Wound healing depends primarily upon the rate of growth of new blood vessels, lymph channels, and fibrous tissue. Since Castilian malva has neither bacteriocidal nor bacteriostatic action, its effect must be due to stimulation or acceleration of the normal process of tissue repair. The histamine-like, vasodilating action of the resin in solution or in ointment form increases the permeability of the capillaries, seemingly decreasing the tension in the walls of the vascular bed by weakening the intracellular cohesion. This is assumed to take place since the lymphagogue action also increases the diapedesis of phagocytes. When this condition is created maximum cellular regeneration takes place.

Castilian malva is applicable only as an adjuvant to promote and stimulate healing in cavities and superficial lesions. It cannot be considered a substitute for proper surgical care.

The discovery of a large quantity of betaine, a trimethyl glycocoll in the plant extract lead to the possibility of it being the active principle of Castilian malva.

Thirty-five gr. of betaine hydrochloride dissolved in 1 gallon of alcohol was used as a 2 per cent solution in the same manner as the resinous tincture. In sixty cases of infected, non-infected and necrotic wounds of the extremities this substance gave no evidence of therapeutic value.

#### CONCLUSIONS

The tincture of Castilian malva is non-toxic when applied to a wound or when ingested.

It is inert in the presence of a hydrogen ion concentration below 6.2.

kidneys, and (4) a decrease in the amount of adrenalin secreted as a result of excitement, fear and other vasomotor stimuli.

The first two results mentioned are irrefutable. The last two are still open to discussion, although there is a growing body of evidence to support them.

Our criteria for operation are in brief: Age, fifty or under. Here again we are more interested in physiologic age than chronologic age, as obviously it would be unwise to deny a patient of fifty-two with elastic arteries the benefits of the operation. We refuse operation to patients who fail to respond in any measure at all to the sodium amytal and sodium nitrite tests.

The sodium nitrite test consists of giving the patient  $\frac{1}{2}$  gr. of the drug every half hour for six doses, and recording the blood pressure every half hour for five hours. In the meantime, the room is darkened, visitors are barred, and nursing care is restricted to absolute essentials. The sodium amytal test follows the same pattern except that 3 gr. of the drug are given every hour for three doses.

In reviewing the results of these tests on our first twenty-nine patients, we have been able to deduct some general statements about their value in determining the approximate final results one might expect in any given candidate or group of candidates for extensive sympathectomy. When under the influence of sodium nitrite the diastolic blood pressure is reduced 20 mm. of mercury or more, the chances are that 64 per cent will have a good final result. When under the influence of sodium amytal the diastolic blood pressure is reduced 20 mm. of mercury or more, the chances are that 60 per cent will have a good final result. The lowering of the systolic blood pressure by these two drugs is a less accurate criterion of the eventual result.

Patients with advanced cardiac and renal damage are refused the operation. The fact that a patient has had a cerebral accident should not bar him from the benefits of sympathectomy, provided that he has made a satisfactory recovery. As a

rule, we refuse operation to very obese individuals and insist that they lose considerable weight before we will reconsider them for surgery. We have not been particularly impressed with the relationship between retinal vessel sclerosis and response to sympathectomy in our series of cases.

Our operative results have been on the whole impressive. Of the twenty-nine patients, two are dead. One died of coronary thrombosis one and one-half years following operation, and the other died as his wound was being closed following a second stage dorsolumbar sympathectomy. This is our only operative death. Post-mortem examination of this patient revealed tremendous cardiac hypertrophy and bilateral pulmonary collapse. In reviewing our case histories, we found that the average preoperative blood pressure was 244/127, and the average postoperative blood pressure taken on an average of 9.8 months following sympathectomy was 166/112. The average reduction in systolic pressure was 78 mm., and the average diastolic reduction was 15 mm. The average systolic drop under sodium nitrite and sodium amytal was 42.7 mm., and the average diastolic drop was 18.2 mm. Comparison of these figures reveals that sympathectomy can better the results of sedative and vasodilating drugs in so far as the systolic reading is concerned, but falls slightly short of their effect as regards the diastolic value. This deduction is predicated on the administration of rather large doses of each drug, i.e., 9 gr. of sodium amytal and 3 gr. of sodium nitrite within separate three-hour periods. These doses would obviously be rather disastrous clinically.

We consider it to be a good result when the drop in systolic blood pressure is 50 mm. of mercury or more, and the drop in the diastolic blood pressure is 20 mm. of mercury or more. Objectively, there has been a good response in eighteen patients, and a poor response in ten. Translated into percentages, we were able to effect objec-

# ESSENTIAL HYPERTENSION

## SURGICAL TREATMENT

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IN the past three years we have treated twenty-nine patients by extensive sympathectomy for essential hypertension. Twenty-four of these patients were operated using Adson's subdiaphragmatic approach, four were operated upon using Smithwick's dorsolumbar approach, and the remaining patient had the Smithwick operation on the right side and the Adson operation on the left side. All of these patients were carefully selected preoperatively and range in age from twenty-one to fifty-eight years. Kidney biopsies were taken from fourteen patients. All but two patients are living at the present time, and it has been possible to make a careful follow-up on each of the surviving patients.

While the surgical attack on hypertension is only slightly more than twelve years old, it is rapidly gaining in popularity. There is still a group of clinicians whom we might call "perfectionists," and nothing short of complete and permanent cure would satisfy them. The surgeon realizes that except in the most ideal cases, he cannot cure hypertension, but he can effect partial cure, temporary alleviation and great subjective improvement in a large percentage of properly selected cases. We believe that there is vastly more to the problem of hypertension than the manometric blood pressure reading, and it is unfair to judge the value of any therapeutic measure solely by this criterion.

Both the subdiaphragmatic and dorsolumbar operations are performed through a lumbar hockey-stick incision. The subdiaphragmatic operation requires a subperiosteal resection of about one and one-half inches of the twelfth rib and consists of removing the first, second, and

sometimes the third lumbar ganglia with the intervening trunk and section of the greater splanchnic nerve as it passes through the crus of the diaphragm, following it in to the corresponding celiac ganglion, and removing two-thirds of the latter. The dorsolumbar operation requires the removal of practically the entire twelfth rib and splitting of the diaphragm; and it consists of removal of the sympathetic chain from approximately the eighth thoracic ganglion through the first lumbar, and the manual avulsion of the greater splanchnic nerve almost as high as the midthoracic region and removing it just as it enters the celiac ganglion. The dorsolumbar operation is obviously the more difficult and dangerous and is attended by a pneumothorax in better than 33 per cent of cases. The pneumothorax can be relieved, however, at the conclusion of the operation by aspiration of air through a soft rubber catheter from the intrapleural space, after which positive pressure is exerted by the anesthetist through the gas machine to reinflate the lung. The mortality rate of the subdiaphragmatic operation is nil, whereas with the dorsolumbar operation it is about 3 per cent. Either type of operation is performed first on the right side and then on the left side, a week to ten days apart.

The rationale for sympathectomy in the relief of essential hypertension is predicated on the following results of the denervation: (1) Relaxation of a large portion of the vascular bed, i.e., the blood vessels of the lower extremities and the splanchnic bed; (2) the postural fall in blood pressure which always follows sympathectomy but usually disappears over a period of months or a few years; (3) increased blood supply to the

# SIMULTANEOUS PERFORMANCE OF RUBIN TEST AND ENDOMETRIAL BIOPSY

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THE Rubin insufflation test has proved itself invaluable in gynecological diagnosis and therapy. The endometrial

to the surface of the cannula and these fragments float off and fall to the bottom of the jar. A syringe is then attached to the

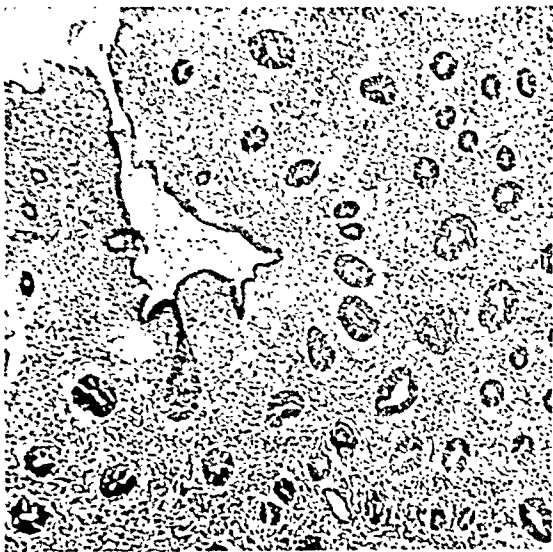


FIG. 1. Endometrium; follicular phase; specimen obtained by suction curette.

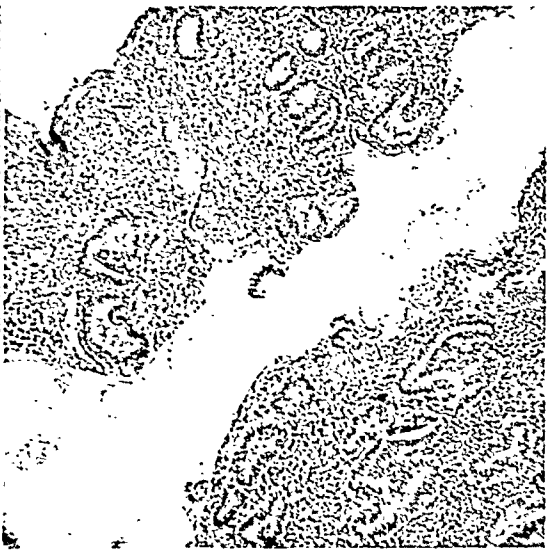


FIG. 2. Endometrium; lutein phase; specimen obtained by intra-uterine cannula.

biopsy is of undoubted diagnostic and prognostic aid. The writer has for some time been employing a technic which simultaneously combines both of the above mentioned procedures.

*Technic.* The patient is prepared as is customary for the performance of the Rubin test. The gas (*carbon dioxide*) is passed through a standard uterine cannula. After the desired quantity of gas has been introduced, a syringe is attached to the distal end of the cannula, and suction is created by pulling the plunger. The cannula is then removed and immediately placed in a jar containing a solution of 10 per cent formalin. Small pieces of tissue are practically always seen adhering

distal end of the cannula and the formalin solution is alternately drawn up and expelled, thus washing out any small pieces of tissue which might be present inside the cannula.

This method has yielded satisfactory sections in the majority of cases. Occasionally, only very small fragments could be obtained by this technic. I find that adequate and excellent sections can always be obtained by using a standard suction curette.

To avoid the possibility of gas embolism and the dissemination of endometrial fragments the sequence should always be first insufflation, followed by suction curettage.



tive improvement in 64 per cent of patients. The average length of known duration of hypertension was 4.9 years. The longest duration was nineteen years, and the shortest was six months. We found no evidence of any relationship between the length of known duration of hypertension and the end results of sympathectomy.

Of the twenty-nine cases, biopsies of the left kidney were taken from fourteen patients. Smithwick has shown previously that biopsies taken from both right and left kidneys in the same patient are essentially similar in so far as pathologic changes are concerned. All of our fourteen biopsies showed pathologic changes, although a few were very mild. The changes were obliterative glomerulosclerosis, with or without interstitial nephritis. One specimen showed tubular nephritis without renal vascular change. Of five patients whose urines were negative as to albumin and the microscopic examination, who concentrated their urine well, and who had normal non protein nitrogens, two showed glomerulosclerosis, one showed tubulonephritis, and the remaining two showed early arterial obliterative changes. It would appear from this that our present common tests for renal disease are not very accurate criteria. Of the fourteen patients from whom biopsies were taken, ten showed good results following sympathectomy. Smithwick has shown recently that of one hundred biopsies taken from patients during the course of sympathectomy for hypertension, 28 per cent showed insignificant or no vascular disease, and in more than one-half the cases the morphologic evidence of renal vascular disease was inadequate to be considered the sole factor in producing the hypertension. He concluded, therefore, that the hypertensive state antedated the renal vascular lesion. As regards the improvement in kidney function following sympathectomy, several of our patients who

before operation had albuminuria now have urines which are albumin free.

So far we have been talking about objective results only; the subjective results are more dramatic. Questionnaires were sent out to the twenty-seven surviving patients. They were given a choice of checking "greatly improved," "moderately improved," "slightly improved," or "not improved," and were specifically requested not to sign their names. All questionnaires were returned and the results were: fifteen greatly improved, nine moderately improved, one slightly improved, and two not improved. Translated into percentages, over 92.5 per cent of patients felt subjectively improved as a result of their sympathectomies. One patient was so enthused about her subjective improvement that she wanted me to advertise the operation over the radio.

#### CONCLUSIONS

We who are operating for the arrest and relief of essential hypertension are, I believe, justifiably enthusiastic about our results. When one considers that the vast majority of patients who seek our aid are referred by clinicians who have already exhausted the medical armamentarium in attempting to relieve them, and we are then able to effect objective improvement in 64 per cent and subjective improvement in over 92 per cent of these cases, it would appear that sympathectomy has a real value, and is here to stay, at least until a better method or methods are discovered. We have occasionally heard the criticism that the operations are too dangerous and strenuous for the patient compared to the relief obtained. Nothing could be further from the truth. There are few operations which are attended by as little risk and postoperative discomfort as extensive sympathectomy, and the relief obtained, as we have shown, speaks for itself.



cocoon extending to above the umbilicus. A flat plate was made of the abdomen in the Out-Patient Department and was essentially

the pulse 90. For two days after admission the patient had slight fever and diarrhea. On the third day in the hospital the diarrhea



FIG. 1. X-ray taken August 12, 1941, after barium enema.

negative other than a moderate lumbar scoliosis.

Physical findings on admission to the hospital were: The patient was a pale woman of 119 pounds with a hemoglobin of 53 per cent, 2,900,000 red cells, 25,000 white cells with 81 per cent of polymorphonuclears. The abdomen, which was the seat of her trouble, presented a large left lower abdominal tumor which extended from the pelvis to above the level of the umbilicus; the tumor was non-tender. The abdomen was tense over the tumor site but the remainder of the abdomen was soft. Bimanual examination revealed the fact that the tumor was evidently intimately associated with the uterus which could not be definitely outlined other than as part of the mass. The tumor was firmly fixed vaginally and abdominally. Rectal examination simply confirmed the vaginal findings. The impression at this time was that the patient had a large malignant papilloma of the left ovary with adhesions and fixation.

The temperature at this time was 99°F., and

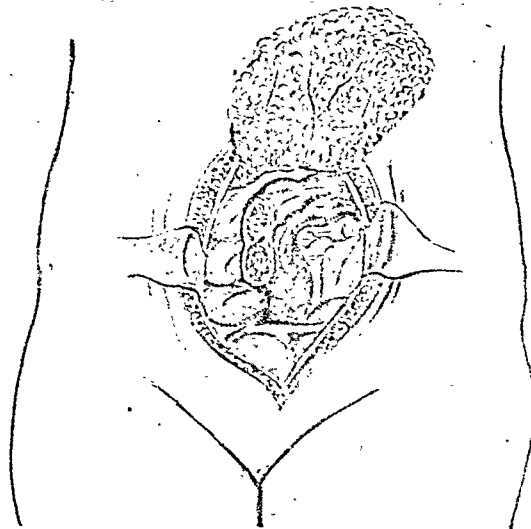


FIG. 2. Operation on August 15, 1941. Appearance of abdominal structures after thick, indurated and beaver-tail like omentum had been freed and delivered. Note the turgid enlarged sigmoid loop with the hemorrhagic and granular ulcerated areas enclosed in thick fibrous walls on its anterior and mesial aspect. Note also the thick parietal peritoneum, the high fundus of the bladder and the dome of a left-sided pelvic cyst.

subsided and the temperature became normal and remained so until after the first operation on August 15th.

On August 11, 1941, the patient was proctoscoped. A yeoman's sigmoidoscope was easily passed for the entire length without anesthesia and without discomfort. A somewhat pale rectal mucosa was evident but otherwise the examination was negative.

X-ray study of colon was done on August 12, 1941. (Fig. 1.) Barium was given per rectum. The report of Dr. Butera was as follows: "Rectum is normal. There is a fairly large defect in region of the junction of the sigmoid and descending colon. This may be due to spasm due to some inflammatory process, but a new growth in this area must be strongly considered. There is some colon spasm of transverse bowel."

It was now believed, in spite of the negative proctoscopy, that the patient had a definite lesion of the sigmoid associated with a large, probably malignant tumor in the pelvis. It did not seem reasonable that the sigmoid alone could account for such a huge, non-tender mass.

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# Case Reports

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## COMPLICATED DIVERTICULITIS OF SIGMOID\*

### CASE REPORT

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MOST of us learn and profit more from our mistakes than from our brilliant successes. Brilliant successes in surgery frequently are published; mistakes, however, are rarely published, so that, as a general rule, we profit only by our own mistakes with only an occasional opportunity to learn and profit by the mistakes of others. It is because of these facts that I report this case which most assuredly presents an error in diagnosis and an error in gross pathological interpretation at operation with consequent unindicated operative procedure.

The case to be presented was unquestionably an unusual one of old perforated and ulcerated diverticula of the sigmoid, diffuse left lower abdominal peritonitis, with an additional old sealed pyosalpinx and para-ovarian cyst on the left side. The history, symptoms and physical findings were misleading and lead to a diagnosis considerably in error. At operation the lesion of the sigmoid was interpreted as a perforating carcinoma of the sigmoid; the sigmoid was resected and a high left permanent single barrel colostomy instituted. Pathological examination of the specimen revealed the entire absence of carcinoma. From that moment on it became the prime objective of the operator to re-establish, if possible, the continuity of the large intestine,

obliterate the colostomy and establish bowel evacuation per anus. The patient had many serious complications and underwent three additional major and one minor operative procedure, but at the end of seven months the objective was achieved and the patient was discharged from the hospital as cured with a continual and progressive improvement in her general health and intestinal function.

### CASE REPORT

Mrs. J. M., a widow, age forty-eight years, was admitted to St. John's Hospital August 7, 1941, and discharged March 7, 1942.

Important facts in her past history were: Appendix and right ovarian cyst removed fourteen years previously; last menstrual period in December 1940, no bleeding since. In March, 1941, she had an attack of upper abdominal pain with distention, nausea and vomiting. She was examined by a private physician and told that she had an ovarian cyst.

The patient was well until two weeks before admission. At that time she developed cramp-like pains, nausea, vomiting and diarrhea. The diarrhea continued and the pain became localized in the upper abdomen. The pain was dull in character and was associated with much abdominal distention. The patient had lost twenty pounds during the past year. She had had some chills and sweats. She was seen and examined in the Out-Patient Department of St. John's and sent into the hospital with the diagnosis of ovarian cyst as large as a

\* From the Surgical Division of St. John's Hospital. This case was presented before the joint open meeting of The Medical Staff of the Brooklyn Naval Hospital and The Brooklyn Surgical Society and representatives of the Medical Department of the Army, at St. John's Hospital, April 9, 1942.

appeared normal and the dome of a left pelvic cyst was visible, the fundus of the bladder was exceptionally high but the left adnexa were not seen. For reasons which are obvious the operator made no attempt further to visualize or free the pelvic organs, nor did he dare explore the right lower abdomen, nor enter the upper abdomen to determine liver involvement and above all he dared not poke into the openings on the sigmoid to determine their destination.

Having in mind the patient's general appearance and condition, the history of the case, the x-ray (Fig. 1) and more particularly the appearance and feel of the sigmoid, the operator, disregarding the negative proctoscopy, felt more than reasonably certain that he was dealing with a carcinoma of the sigmoid and that the carcinoma had perforated the wall of the sigmoid. Exteriorization of the sigmoid loop would have been the best procedure but an attempt revealed the fact that the lower end of the sigmoid could not safely be brought out far enough to reach healthy intestine. Resection of the sigmoid was then decided upon and carried out from above downward. The blind end of the rectosigmoid was dropped into the pelvis and the end of the descending colon was brought out through a stab wound lateral to the original incision to form a permanent left colostomy. The original incision was closed in layers using interrupted silk-worm gut in the skin. No drainage was instituted. The Payer clamp by means of which the proximal end of the descending colon had been drawn through the stab wound was allowed to remain on. Operative time was one hour and twenty minutes under spinal anesthesia. The postoperative diagnosis was perforated carcinoma of the sigmoid, diffuse plastic and suppurative peritonitis of the left lower abdomen and pelvis and a pelvic cyst (exact origin of same undetermined.)

Immediately after the operation the operator opened the sigmoid. Much to his dismay he found the walls of the sigmoid very thick, the lumen small but no evidence of carcinoma of the inside of the sigmoid. The ulcerative lesions were entirely on the outside of the gut extending deeply into the walls of the sigmoid but actual communication with the lumen could not be demonstrated. Apparently he had been dealing with perforated, necrotic and eroded diverticula. The pathologist's diagnosis was: "Acute and chronic focal colitis and pericolicitis consistent with diverticulitis."

The immediate postoperative treatment was routine intravenous glucose and saline and in addition on the afternoon of the day of oper-

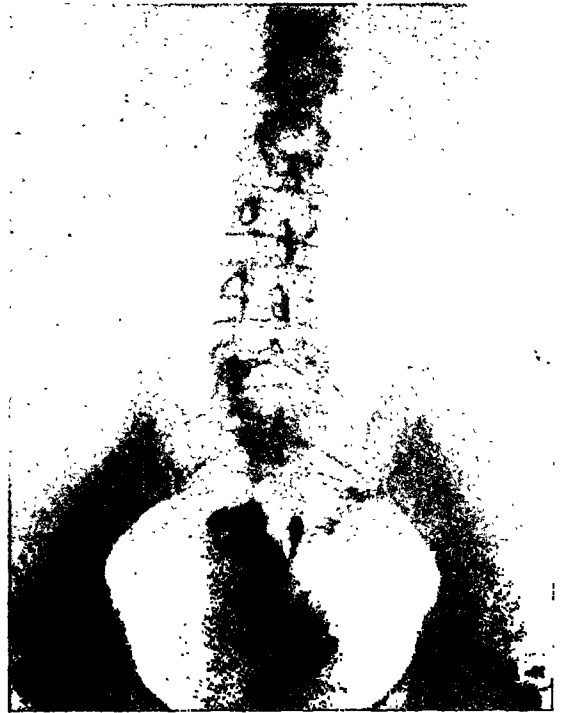


FIG. 4. Large amount of barium remaining in blind rectosigmoid and rectum on September 22, 1941, following repeated and thorough irrigations in attempts to remove it after its injection as part of an x-ray study on September 19th. It had to be removed manually.

ation the patient was given 3.75 Gm. of sulfathiazole in 250 cc. of distilled water intravenously.

Postoperatively the patient's temperature rose to 103°F. with pulse of 150. Within sixteen hours the temperature dropped to 100°F. and pulse to 96. The patient was febrile for nine days with remissions never exceeding 100.6°F. and pulse of 120. After the ninth day the temperature was normal and the pulse 90 or less.

The condition of the wound was not so encouraging. Five days postoperatively severe wound infection was present with almost complete breaking down to the peritoneum. Fortunately, no peritonitis developed. The strip of skin between the colostomy stab wound and the left paramedian incision became completely eroded, the end of the bowel was drawn deeply into the wound but functioned exceedingly well, pouring feces directly into the large gaping wound. On August 22nd, seven days

On August 13, 1941, 500 cc. of citrated blood was given.

The first operation was performed on August

moderately free. The right lower abdomen and upper abdomen were now walled off with pads. The omentum was then separated by

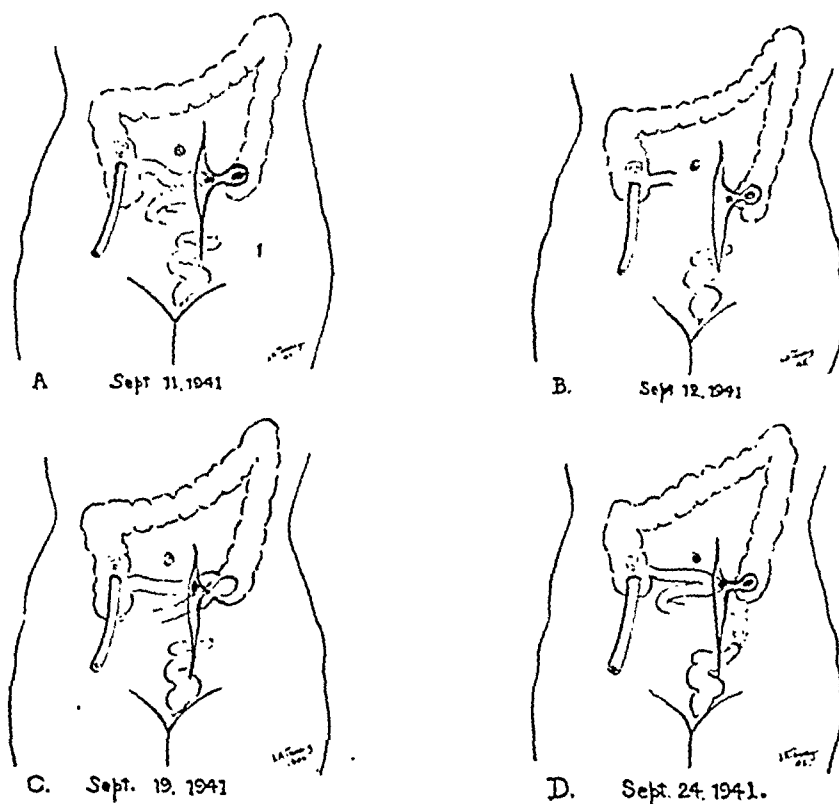


FIG. 3. Schematic drawings of our impressions regarding the openings in the intestinal tract between September 11, 1941, to September 24, 1941. These impressions are fully described in the text.

15, 1941. (Fig. 2.) The object of the first operation was to clear out the pelvis, if possible, examine the colon and make it possible to perform the necessary intestinal surgery at a later date. That, of course, was the pre-operative objective which the operator had in mind. A left paramedian incision was made from above the umbilicus to the symphysis, and the rectus muscle dislodged to the left. When the peritoneum was reached the operator immediately surmised that he was soon to have difficulties. The peritoneum with a small amount of extraperitoneal and some sub-peritoneal fat was the seat of an inflammatory edematous process and varied from  $\frac{1}{4}$  to  $\frac{1}{2}$  inch in thickness. It was carefully incised and the omentum was found immediately beneath and adherent to same. The entire omentum seemed to be on the left side of the abdomen being bound down in the pelvis and adherent to the fundus of the uterus superiorly and posteriorly and to a mass beneath, which corresponded to the location of the sigmoid. The left and right edges of the omentum were

blunt dissection and during this process two pockets of frank yellow pus were entered, one at the right fairly high up and one in the lower left pelvic area. This pus cultured hemolytic streptococcus predominating, with *Bacillus coli* and *Bacillus subtilis*. The pus was aspirated and the areas sponged dry. No well defined pockets were demonstrable during the operation. The omentum was now delivered out of the abdomen. It presented a very extensive inflammatory reaction being markedly contracted, about one inch in thickness, firm and edematous and looked like a miniature beaver's tail.

The left lower abdomen presented the following: Numerous adhesions throughout, a tense, rigid sigmoid loop with extensive fixation and bound down to the uterus. On the anterior mesial aspect of the sigmoid at about the middle of the loop there were two open areas adjacent to one another with thick glistening walls and filled with a granular, grumous, red material which certainly looked like ulcerated carcinoma. The top of the fundus of the uterus

carefully watched and grossly examined and the x-ray with barium was used.

The results were carefully noted on the

condition existed: Cecostomy with catheter, colostomy spontaneously closed, fistula from the ileum with an additional fistula between

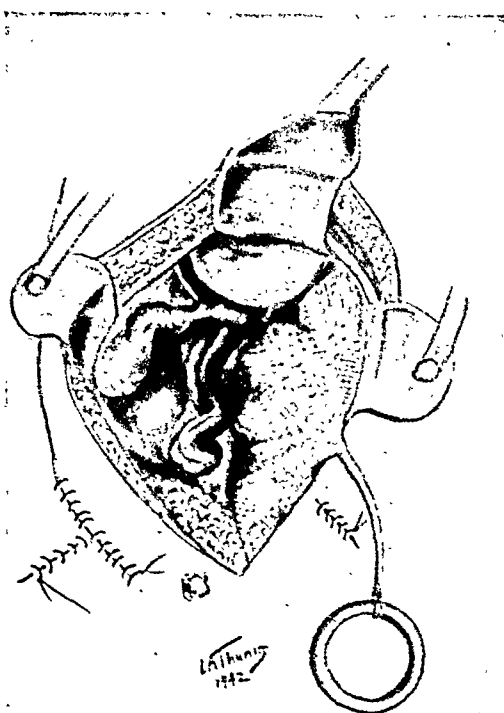


FIG. 6. Third operation, November 28, 1941; second phase. An end-to-end repair of torn ileum as shown in Figure 5 has been completed and the entire pelvic small gut has been displaced into the right side of abdomen. Many pelvic adhesions have been removed and what looked like a mass is shown to be the rectum and rectosigmoid, a blind pyosalpinx and parovarian cyst. The bladder is still unusually high almost obscuring a small uterus. The drawing presents operator's view looking down from above into the pelvis.

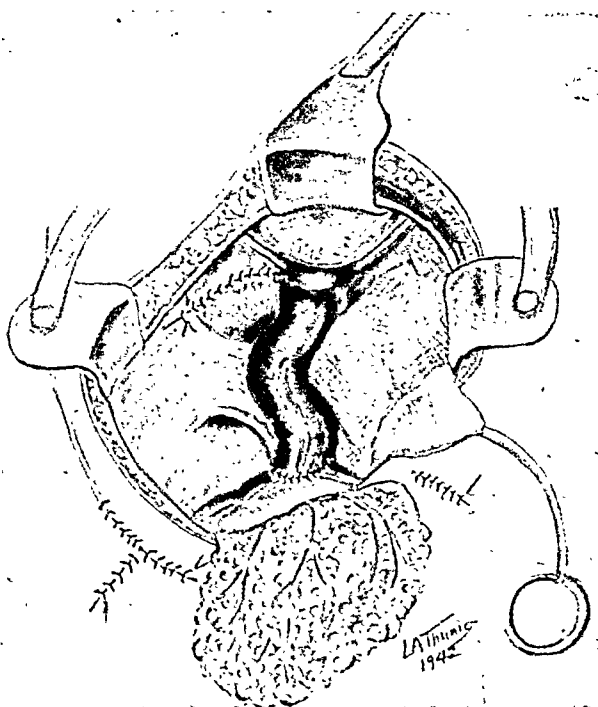


FIG. 7. Third operation, November 28, 1941; final phase. Left tube, parovarian cyst and left broad ligament (Fig. 6) have been removed and edges of base of broad ligament sutured. (The left ovary was not identified at operation nor in the laboratory; it may have been part of the large pyosalpinx and its identity lost; the author is positive that no left adnexal structures remained within the pelvis.) The rectosigmoid has been anastomosed to the transverse colon. Drawing presents operator's view looking from above downward into pelvis.

patient's record and I shall quote them in chronological order: (Fig. 3A-D).<sup>\*</sup> September 11, 1941: At this time we believed the following to be present: Cecostomy with Pessar catheter *in situ*, colostomy left, fistula from the terminal ileum near the colostomy opening and blind rectosigmoid in the pelvis. September 12, 1941: We now believed the following to be the case: Cecostomy with catheter, colostomy, no fistula from ileum, but an additional opening in the terminal descending colon near the colostomy opening and a blind rectosigmoid in the pelvis. September 19, 1941: We believed the following

<sup>\*</sup> The diagrams in Figure 3 were drawn and recorded on the patient's hospital record with the reasons for the deductions on the dates given on Figure 3.

loop of ileum and the terminal descending colon, and blind rectosigmoid in pelvis. On this day, thirty-five days after the rectosigmoid had been carefully closed, it was deemed safe to make an x-ray study; barium was gently injected into the blind rectosigmoid, into the cecum and into the colostomy wound. The report was not helpful; it simply stated: Rectum patent to rectosigmoid. Barium through cecostomy outlines a short ascending colon. At this early date the author was hopeful that someday he might be able to re-establish the continuity of this large intestine, and knowing the pitfalls due to a slug of barium distal to a large intestinal anastomosis he wanted to make very certain that this rectum and rectosigmoid were empty. The rectum was carefully irrigated with only slight return of the barium injected

after operation, it was noted that gas and some undigested food definitely not fecal was escaping from an opening in the wound very

cecostomy operation was followed by absolutely no general or wound reaction.

For the time being it became our objective

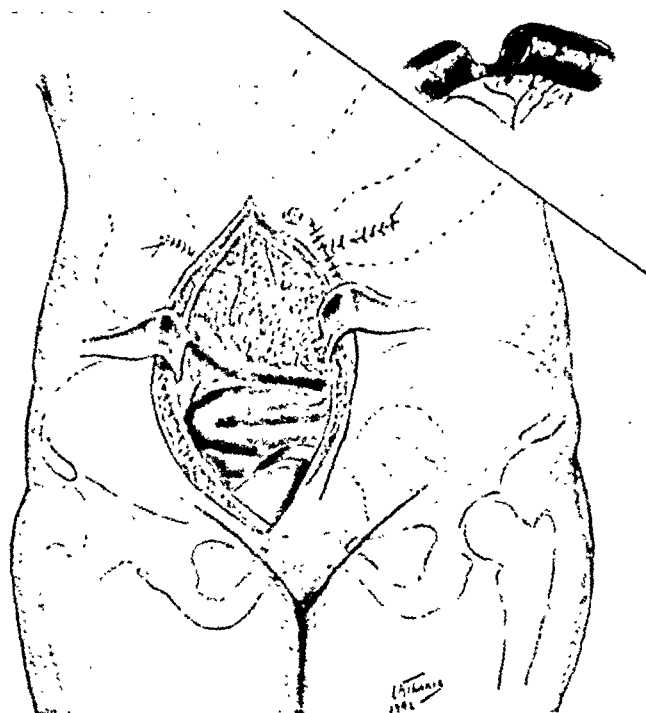


FIG. 5. Third operation on November 28, 1941. Condition found upon incising the peritoneum. A terminal loop of ileum traversed the middle of the operative field and its angle was densely adherent to the undersurface of the original left paramedian incision of the first operation (August 15, 1941). This was unquestionably the site of the small gut fistula as surmised in Figures 3A and B. Omentum slightly adherent to upper but distal arm of loop. Insert shows damage to ileum in its separation from old scar. The abdomen shows the colostomy and cecostomy openings as temporarily sutured on November 27, 1941. The small catheter placed in the cecostomy opening for decompression was removed prior to operation. (The adhesive plaster coverings which were present during operation are obviously not shown.)

close to, but apparently separate from the colostomy opening. By August 24th, it was very definite that an intestinal fistula had developed in the wound. However, in spite of this the patient did well generally; there was no systemic reaction and granulation tissue developed in the wound.

With the hope that some of the fecal material might be diverted from the left abdominal wound, on September 8, 1941, twenty-five days after the first operation, the author performed a sleeve cecostomy under cyclopropane and oxygen. The function of the cecostomy with a large size Pessar catheter *in situ* varied from copious to very scant output. The

to attempt to visualize the exact relationship of the blind rectosigmoid to the remaining large intestine and also to establish if possible the intestinal site of the additional fistulous opening in the wound on the left side of the abdomen. This additional fistulous opening was so close to the colostomy opening that it could never be definitely located in spite of many attempts to do so by means of catheters. We used various irrigations through the cecostomy and colostomy and what we presumed to be the additional fistulous opening, noted the time of return and the character of the returned fluid. The spontaneous and variable excreta of the three openings were

through a short loop of distal ileum. The closeness of the fistula and the colostomy would make it impossible for the observer to be certain as to the exact point of exit. Subsequent operation on November 28, 1941, proved that impressions A and D in Figure 3 were correct as regards the small intestinal fistula being in the terminal ileum: no evidence of any existing tract between the blind rectosigmoid and the ileum and or the terminal descending colon could be found then or at a still later operation.

Generally, the patient was doing well; the colostomy and cecostomy were both functioning; the wound on the left side was clean and granulating. About the middle of October the fistula from the ileum had closed and remained closed and only typical colonic feces was being excreted. On October 17, 1941, the patient was out of bed and remained ambulatory until November 27, 1941. She had gained weight, was eating well and feeling fine. On November 11, 1941, her hemoglobin was 72 per cent, red cells 3,500,000, white cells 7,350 with 65 polymorphonuclears. On November 17, 1941, I again proctoscoped her, the rectum was empty and clean but still showed some mucosal irritation, unquestionably due to the hard dry slug of barium and the strenuous efforts to remove same. X-ray with the proctoscope *in situ* gave only a fair idea of the upper limit of the rectosigmoid.

On November 24, 1941, the patient was started on sulfaguanidine, 2.5 Gm., every eight hours. Cultures were made before administration and on November 27, 1941, but unfortunately through a misunderstanding colony count was not made.

On November 27th, the large intestine was thoroughly irrigated through the cecostomy and the colostomy. The colostomy and a very small area of unhealed wound were temporarily sutured over; the cecostomy was drained with a small catheter and also temporarily sutured tight about the catheter. Both openings were then closed over with adhesive plaster.

On November 28, 1941, the third operation was undertaken. The preoperative objective was to clean out the pelvis, free the rectosigmoid and establish an end-to-side anastomosis between the rectosigmoid and transverse colon. The transverse colon was chosen because it was most accessible, its circulation had not been disturbed, it was most distant from infected tissues and it would be unnecessary

to disturb or possibly open up infected areas. Furthermore, an anastomosis with the transverse colon had the distinct advantage of

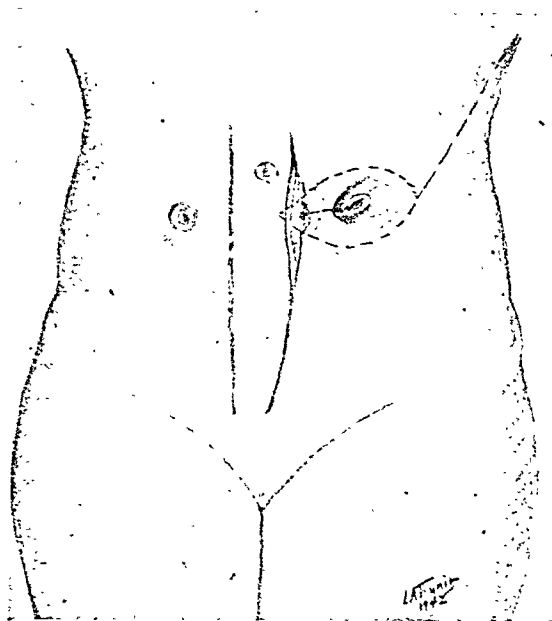


FIG. 9. Appearance of the abdomen from December 24, 1941, to February 16, 1942. The broken line represents line of incision for final operation on February 16, 1942.

being decompressed proximally by the cecostomy and distally by the colostomy. Its great and serious disadvantage was the likelihood of establishing a permanent cesspool in the distal colon in the event of a successful anastomosis and spontaneous closure of the colostomy. The author carefully weighed all the probabilities and possibilities and still decided upon the transverse colon even though it might lead to a partial colectomy later.

Anesthesia was continuous spinal. A right paramedian incision was made. Upon opening the abdomen a loop of terminal ileum traversed the central part of the opening. (Fig. 5.) The omentum was thin and adherent to the upper but distal arm of the loop. The loop was firmly attached to the undersurface of the original left paramedian incision of the first operation (August 15, 1941); the empty bladder was unusually high. It was imperative to get the loop of ileum out of the way if the pelvis was to be explored and an anastomosis performed. This was done with the greatest of care. The omentum was gently freed from the upper but distal loop and then the angle of the loop, which unquestionably had been the site of the small intestinal fistula described in previous paragraphs, was separated. In spite of all pre-



on September 19th. After numerous irrigations an x-ray was made September 22, 1941, (Fig. 4) and showed a large slug of barium still present

terminal ileum, rectosigmoid with two tracts, one from rectosigmoid to colostomy and one from rectosigmoid to ileum. At the time the

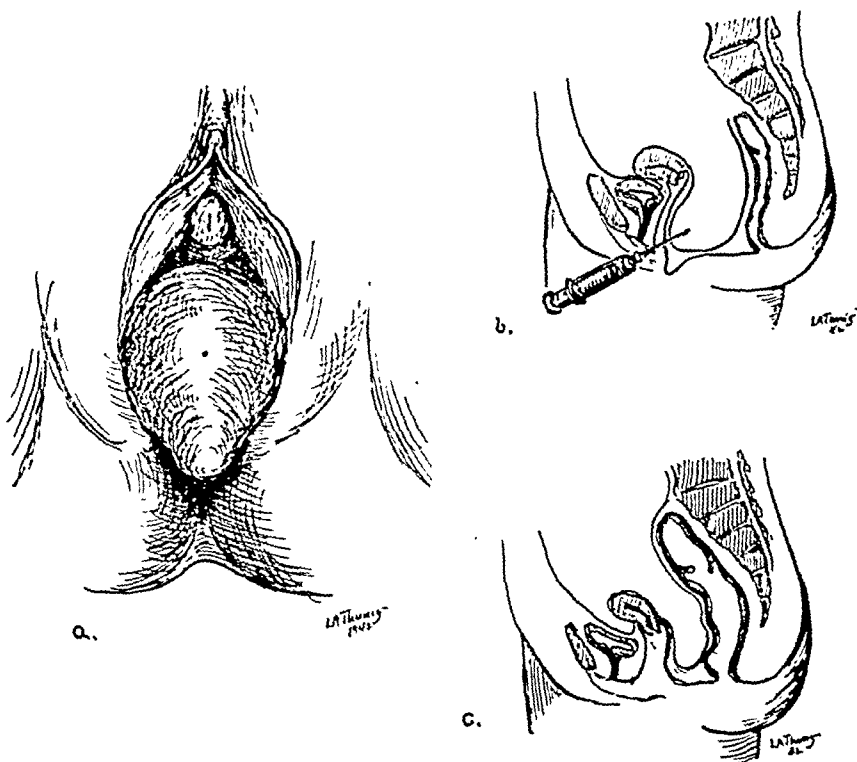


FIG. 8. a, Actual appearance of patient's perineum on December 9, 1941, eleven days after her third operation. (Figs. 5, 6 and 7.) The dot in the posterior vaginal midline represents point of aspiration. (The large fluctuating abscess could be felt between vagina and rectum with a finger in each orifice.) b and c, Diagrammatic drawings showing compression of rectum and vagina before and after the final evacuation of the abscess. The patient evidently had an unusually low cul-de-sac of Douglas.

in the rectum. Irrigations were continued but failed and eventually the barium was removed by manual extraction. On September 24th, however, following a pint irrigation of the rectum by the intern, the intern reported that the irrigating fluid had gushed out of the colostomy and the cecostomy simultaneously. The intern was an excellent observer but I was inclined to doubt this observation and, accordingly, personally irrigated the rectum with a pint of methylene blue solution. The intern's observation was correct: the methylene blue appeared almost immediately in copious amounts from the cecostomy and colostomy. This was forty days after the rectosigmoid had been firmly closed.

Thus on September 24, 1941, we again changed our opinions and believed the existing conditions to be as shown in Figure 3d: Cecostomy with catheter, colostomy, fistula from

condition was noted we believed that two tracts were present and essential to produce the simultaneous expulsion from the cecum and colostomy for it seemed obvious that under no circumstances could one pint of water traverse the entire colon from colostomy to cecum or from cecum to colostomy, in the event of the tract emptying only into the ileum, in such a short space of time. A tract or tracts obviously did exist. It is quite conceivable, however, that only one tract was present and that one from the rectosigmoid to the ileum close to its fistulous opening. As has already been stated, the small fistula from the ileum opened so close to the colostomy that the two openings could not be differentiated, hence water injected into the rectum and emptying by means of a tract into the ileum could easily come out simultaneously through the fistulous opening and through the cecum by a short cut

relaxed at the time of admission to the hospital. The temperature on the seventh and eighth days rose to 101.8°F. and pulse to 110. There was some very superficial wound infection but the wound did not seem sufficient to account for the rise in temperature and pulse; it was perfectly clean by the tenth postoperative day. The fullness in the perineum and especially in the posterior vaginal wall, however, increased tremendously and by December 9th, the eleventh day postoperatively presented a picture as shown in *a* in Figure 8. The tit-like projection of the posterior vaginal wall was edematous and projected out over the perineum obscuring the anus; above this it was fluctuant. A fine gauge needle and then a No. 13 gauge needle was introduced at the point marked with a dot (Fig. 8A, *a*) and 300 cc. of a thin, foul, brownish material was obtained which cultured hemolytic streptococcus, *Bacillus coli*, *Bacillus proteus* and *Bacillus subtilis*. No fecal particles were present. The temperature and pulse fell for a brief period of twenty-four hours, then rose again and coincidentally the abscess cavity filled up again. On December 15, 1941, the fifteenth day postoperatively while preparations were being made for incision of the posterior wall the temperature was 101.8°F. and pulse 110 when suddenly the abscess ruptured through the previous aspiration hole and approximately two pints of a foul, greenish thin pus escaped; this, of course, could not be cultured. At this time the patient was and had been receiving iron and vitamin B which produced intensely black stools from the cecostomy opening (Pessar catheter had been removed December 7, 1941), from the colostomy and from the anus. Yet there was no trace of this in the abscess contents nor were any fecal particles present, hence it was a safe assumption that infection unquestionably had taken place but the anastomosis had held. The temperature and pulse immediately fell to normal after the spontaneous evacuation of the pus and remained so until February 17, 1942, the first postoperative day after her final operation. There was a slight vaginal discharge through the puncture wound for nine days but this ceased permanently on December 24, 1941, on which day the patient was allowed out of bed, and remained ambulatory until February 16, 1942.

The patient showed great improvement in her general condition. The cecostomy had

spontaneously closed down to a small but still functioning vent; the right paramedian incision was completely healed; the colostomy was very

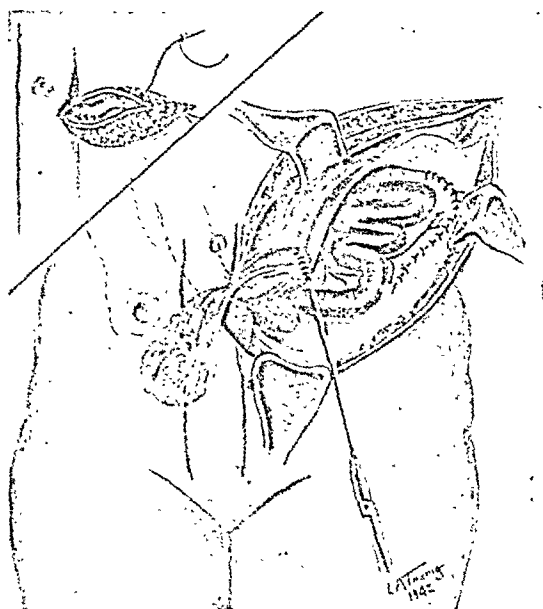


FIG. 12. The condition of the abdomen is presented after the partial colectomy has been completed and the intra-abdominal work completed. The cut rectus muscle is visible in the mesial side of the incision. The tip of the spleen and part of the greater curvature of the stomach were clearly exposed above. The open space between mesocolon and gastrocolic ligament terminating at sutured end of transverse colon are shown. The long double suture ends used to fix stump to anterior parietal peritoneum are held in hemostat. Upper end of rectosigmoid and anastomosis are pulled with slight traction into lower angle of wound. Suture line represents repaired base of left transverse mesocolon and base of cut peritoneum covering descending colon. Insert shows handling of colostomy end of incision.

small and the original left paramedian incision was healed with the exception of a small superficial area at its upper angle. A fairly wide strip of skin had again grown between the incision and the original colostomy site, but a sinus lead under this strip from the colostomy site into the superficial surface of the unhealed upper angle of the wound proper and some feces accordingly continued to contaminate this upper angle. The abdomen appeared almost the same as it did February 16, 1942, and is graphically shown in Figure 9.

On January 7, 1942, about forty days after the end-to-side anastomosis it was deemed safe to make another x-ray study with barium given per anus. (Figs. 10 and 11.) The x-ray report mentioned a Y-shaped anastomosis

cautions, when the loop was completely separated and delivered, it presented the appearance as shown in insert of Figure 5. The

Pathological diagnosis: Chronic salpingitis with pyosalpinx and para-ovarian cyst.

The rectosigmoid was now gently freed from

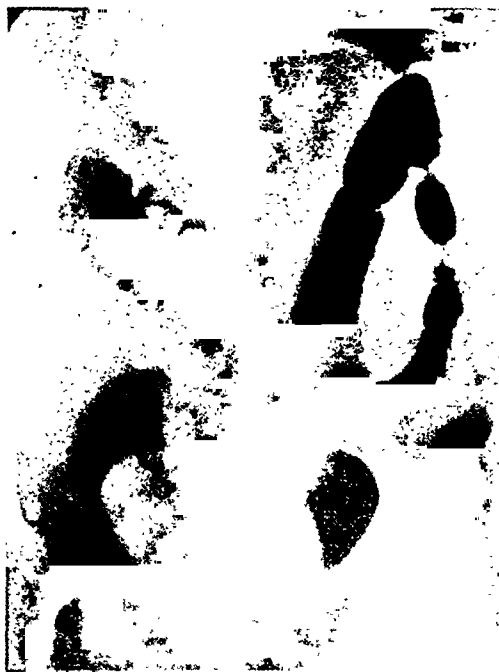


FIG. 10. January 7, 1942, forty days after establishment of end-to-side anastomosis; barium given per anus. This x-ray was made almost immediately after injection.



FIG. 11. January 7, 1942, taken a short time after Figure 10 as the intestine was emptying.

two ends were held together by the smallest strip of intestine on the mesenteric side. A two tier end-to-end anastomosis was performed and now without difficulty the entire pelvic and lower abdominal small intestine was easily placed into the right lower abdomen and held there by means of a pad. Fortunately, there was essentially no spilling from the collapsed and almost empty ileum.

A good view of the pelvis was now obtained. The uterus was very small and the vesico-uterine fold was practically obliterated by adhesions. To the left there was a mass bound up in adhesions. When the adhesions were separated and the structures freed, the mass was found to consist of the rectum and rectosigmoid, a cyst about 7.5 by 5 by 4.5 cm. (laboratory measurements) and a tubal mass 6 by 1.5 cm. (laboratory measurements). *In situ* the structures now presented a picture as shown in Figure 6. The left broad ligament was markedly thickened. The tube, cyst and major portion of the broad ligament were removed *en masse*; this left essentially nothing in the pelvis except bladder, uterus and rectum.

the pelvic floor and about  $\frac{1}{2}$  inch of the blind end cut straight across. The transverse colon was easily brought down and an end-to-side anastomosis performed as far to the left of its middle as was possible without tension. Four Gm. of sulfanilamide were sprinkled into the abdomen and the abdomen closed tight without drainage. The operation took considerable time, two hours and twenty-five minutes. (Fig. 7.)

Postoperatively the reaction was extremely light; for the first three postoperative days her temperature did not exceed 100°F. with the exception of a period of four hours on the second day when it reached 101°F. Her pulse was between 110 and 120 but dropped to 90 on the second day and remained under 100 until the fifth postoperative day. On December 1st, her third postoperative day she had a small spontaneous stool per rectum, her colostomy and cecostomy had of course been opened again shortly after this operation. On December 3rd, her fifth postoperative day, her pulse rose to 120 and on December 4th her temperature rose to 100.8°F. About this time a fullness was noted in the perineal floor which was moderately

was added to the proposed occlusion of the transverse colon distal to the anastomosis. This cecostomy was soon to close spontaneously and the element of safety would not be there for a later operation.

4. This patient's abdominal tissues were most assuredly now immunized not only against several species of bacteria but also to trauma and handling.

5. An urgent desire on the part of the author to complete what he had planned for several months (hardly to be considered a justifiable cause for operation).

On February 16, 1942, eighty days after the end-to-side anastomosis, the final operation was undertaken. Under sustained spinal anesthesia a flank incision was made surrounding the colostomy, with a safe margin of skin at its mesial end and terminating at the end of the eleventh rib laterally. (Fig. 9.) The bridge of skin between the actual colostomy opening and the unhealed upper angle of the left paramedian incision (Fig. 9) was cut across and the undersurface of this bridge and the actual colostomy opening were closed with a short continuous suture. (Insert Fig. 12.) The elliptical incision as shown in Figure 9 was carried down through skin and subcutaneous tissues and its upper and lower wide flaps were tightly sutured over the top of the now closed colostomy opening. (Insert Fig. 12.) The abdomen was not reprepared; gowns and gloves changed and the operation continued.

The lateral end of the incision was now carried down to the external oblique aponeurosis and muscle. Dissection of the colostomy area was carried down until the abdominal cavity was entered, the dissection being made as far away from the gut as possible with the conservation of as much abdominal wall as possible. It must be borne in mind that at the first operation the presumed permanent colostomy was brought through the rectus muscle, hence in removing this colostomy the rectus was cut completely across as shown in Figure 12. The section of the lateral abdominal muscles and peritoneum was carried out so that the whole left upper and middle abdomen was laid wide open with excellent exposure. With the colostomy site entirely freed and with a most unexpected absence of adhesions the remainder of the operation was extremely simple and easy. The phrenocolic ligament was cut and the descending colon and splenic flexure were easily

handled. The branches of the left colic artery were ligated, care being taken to avoid the inferior mesenteric and its superior hemor-



FIG. 15. This shows the condition of the remainder of the large intestine on March 6, 1942, eighteen days after the partial colectomy. The short ascending colon and hepatic flexure did not fill and contain air. The closeness of the anastomosis to the blind end of the transverse colon and the consequent almost complete absence of a distal colonic pouch are well shown. The barium was given per rectum.

rhoidal branch. The peritoneum was incised and the gut freed. As the splenic flexure and left arm of the transverse colon were reached the vessels were ligated quite close to the gut to avoid inadvertently ligating a large branch of the median colic. The peritoneum of this gut, including the left half of the transverse mesocolon and gastrocolic ligament, was cut and the entire large intestine from colostomy to about two inches distal to the end-to-side anastomosis was now out of the abdomen. Gentle tension on this gut brought the site of the end-to-side anastomosis into view and the transverse colon was clamped not more than two inches distal to the distal end of the anastomosis. The transverse colon was cut across, and sutured and inverted and a second tier of sutures placed to assure absolute closure. The ends of this suture were allowed to remain long and were used to fix this stump to the undersurface of the anterior parietal peritoneum after its closure was nearly complete, this to

between rectosigmoid and transverse colon that functions well. Figure 10 was taken immediately after the enema had been given;

colonic contents to pass over the anastomosis and empty into the descending colon the author believed the following conditions prob-

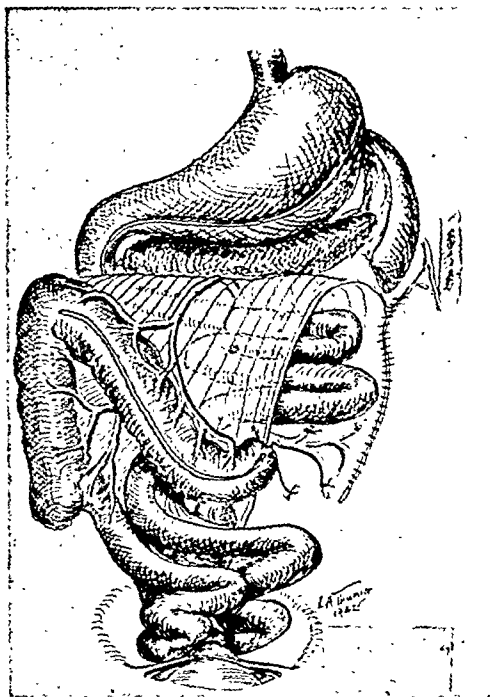


FIG. 13.

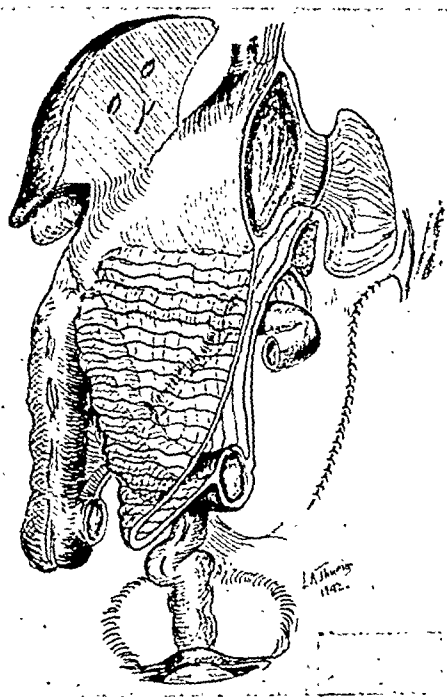


FIG. 14.

FIGS. 13 AND 14. Diagrammatic drawings of the anatomy in this case as it was at the end of the last operation.

Figure 11 was taken after the evacuation of the barium had started. The interesting point is that in spite of the anastomosis and favorable conditions for the aid of gravity the peristalsis of the large intestine pushed a considerable part of the barium over the splenic flexure into the descending colon as is definitely shown in the x-ray. This fact with many others lead the author to believe that a colectomy of the transverse colon, distal to the anastomosis, the splenic flexure and descending colon to the colostomy would become necessary.

About February 9th, with a definite desire on the part of the patient to have the colostomy removed a final operation was decided upon. The condition of the abdomen was as shown in Figure 9 which also shows the line of incision for the final proposed operation. The general condition of the patient was excellent. The justifications for this final step at this time were as follows:

1. This patient insisted that she be relieved of the discomfort she had undergone for six months due to her colostomy.
2. With the tendency of a large part of the

able in the event of not performing a colectomy:

- (1) Failure of the now very small colostomy to close spontaneously;
- (2) failure of even an operative attempt to close such a colostomy;
- (3) that should the colostomy close either spontaneously or by operation the distal transverse colon and descending colon would become a huge non-emptiable cesspool which would endanger the patient's health and life. Hence closure was definitely contraindicated.
- (4) If the colostomy remained open, as it probably would, and the natural function of the colon persisted in by-passing the anastomosis, the author believed that the patency of his anastomosis was threatened, that it might contract or even close, that six months of work would have been in vain and the patient would still have her colostomy. The distal and proximal decompression which seemed such consoling factors at the time of the side-to-end anastomosis might now become the undoing of the anastomosis which they helped to establish safely.

3. With a still functioning cecostomy, even though very small, a great element of safety

tion of the rectum, the remaining half of the transverse colon and the inferior leaf of the transverse mesocolon. The posterior boundary is the essentially intact posterior parietal peritoneum. The probabilities of the transverse mesocolon becoming adherent to the posterior parietal peritoneum and thus obliterating, *in toto* or in part, the upper portion of the major peritoneal space with the possibility of herniation of small intestine through an open area in such adhesions seems very slight particularly when you bear in mind that at the last operation the author fixed the stump of the transverse colon to the anterior peritoneum. At that time he did so to produce an immediate point of fixation for the formation of a fecal fistula to the outside in even of leakage of the stump. It is now quite evident, however, that entirely unintentionally, he held the colon stump and adjacent anastomosis and upper rectosigmoid anteriorly and in so doing also kept the transverse mesocolon and gastrocolic omentum from collapsing against the posterior parietal peritoneum. The probabilities of extensive adhesions or constrictions or herniation in the lower and pelvic portion of the greater sac do not seem very likely in view of the fact that the peritoneum here was untouched at the last operation and the trauma of the third operation (removal of tube and cyst and anastomosis) had entirely disappeared by the time of the last operation.

After the patient's discharge from the hospital she was treated at the author's office. On March 23, 1942, only gas passed per cecostomy; the triangular area was granulating. On June 5, 1942, she was completely healed and the cecostomy firmly closed. On October 10, 1942, the patient looked exceptionally well; her weight was 131 pounds. She stated that she ate everything with no sign of any discomfort and that her bowel function was perfect. The author has heard from her since only indirectly but the reports continue to be most satisfactory.

#### CONCLUSION

1. This case presented an unusual and misleading history.
2. The physical findings and general appearance were suggestive of malignancy.
3. The x-ray was suggestive of malignancy in the colon.

4. The gross pathological picture of the sigmoid at operation looked almost typical of a perforated carcinoma of the sigmoid.\*

5. Based on the four preceding factors the author performed a resection which the pathological examination showed to be unnecessary.

6. The subsequent operations were performed as dictated by the author's judgment; the case was singular and there was no precedent to follow. What was done was thought to be the best choice under the circumstances but the author does not even suggest that such was the case; he is merely reporting what he did do.

7. The case did terminate with an excellent intestinal function and a progressive state of good health.

8. The author states very frankly that for nearly seven months a large part of each day was devoted to this case. Most of the dressings (and they were not pleasant dressings) were performed or supervised by the author. But, with all that, the author believes that the fortunate outcome in this case was contributed to largely by a most co-operative, courageous and pleasantly disposed patient, an excellent and observing intern staff, a large measure of good fortune and pre-eminently to a most conscientious, interested, willing, co-operative and keenly observant nursing staff whose duties in this case over a period of months were anything but pleasant.† I feel certain that they deserve the greater part of the credit for the happy ending.

\* The author's error in this operative pathological interpretation was, needless to state, not only a jolt to his surgical diagnostic acumen but also to his background in pathological training. From 1912 to 1920 the author acted as surgical pathologist to not less than four Brooklyn hospitals.

† When, in an intestinal case, among many details in the nurses report you find: "Patient had a spontaneous bowel movement which consisted of three pieces of dark brown stool the largest being about two inches long and an inch in diameter the other two pieces considerably smaller," then you can be pretty certain that that patient is being carefully watched.

produce an external fecal fistula in the event of postoperative leakage. The edges of the cut posterior parietal peritoneum were brought

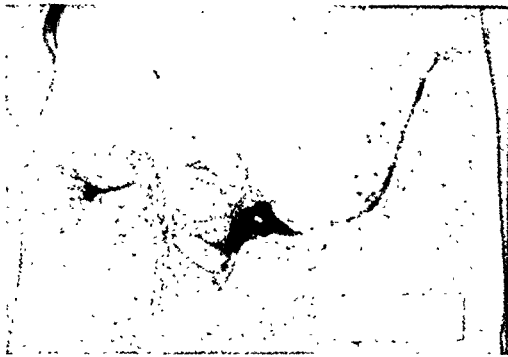


FIG. 16. Photograph of the abdomen taken a few days prior to discharge. By June 5th, the superficial areas, still unhealed at time of photograph, were completely healed and cecostomy tightly closed.

together from the lower end to the base of the remaining half of the transverse mesocolon. No attempt was made to suture the transverse mesocolon to the edge of the gastrocolic ligament. There is essentially no loose gut or other structure to herniate out of that space (Figs. 12, 13 and 14) and the author deemed it wiser to leave it wide open than to suture same and possibly leave a small hole through which something might herniate in. The abdomen was now closed, special attention being paid to the reconstruction of the rectus muscle and its sheath. The abdomen was closed tight without drainage. The operation had progressed so smoothly without any mishap that sulfanilamide was not used. Operative time was one hour and fifty-five minutes. The pathological report was: Thirty eight cm. of large intestine with a single diverticulum in its distal portion.

The postoperative course was most satisfactory. The maximum temperature was 101°F. and pulse 120 with gradual decline and a normal temperature and pulse of 80 on the fifth postoperative day. There was superficial colon bacillus infection at the old colostomy site with foul brown pus and slight necrosis. The bowels moved spontaneously on the third postoperative day. On the eighth day postoperatively the temperature rose to 101.4°F. On February 26th, ten days postoperatively a large but very superficial abscess localized in the upper lateral aspect of the wound. This was opened with a small separation of the incision with the copious discharge of frank

yellow pus. Temperature immediately fell to normal and remained so for the duration of the hospital stay.

The patient was out of bed on March 1, 1942, thirteen days postoperatively. On March 6, 1942, eighteen days postoperatively, the condition of her large intestine was as shown in Figure 15. She was discharged March 7, 1942, twenty-one days after the colectomy and seven months from the day of admission, August 7, 1941. Her condition on discharge was excellent; the patient stated: "I feel better than I have felt in two years." Cecostomy was just about open. The bowels were functioning well. The wounds were healed with the exception of a superficial triangular area at the old colostomy site as shown in the photograph of the abdomen taken a few days before discharge. (Fig. 16.) Her weight was 119 pounds and her blood showed a hemoglobin of 70 per cent, red cells 4,000,000 and white cells 13,500 with 62 per cent polymorphonuclears.

Figures 13 and 14 described more fully under the legends accompanying same represent semi-diagrammatic anatomical drawings of the anatomy of the abdomen at the completion of the last operation. Copies of these drawings were filed with the patient's hospital record so that in the event of Mrs. J. M. ever suffering another abdominal catastrophe, the surgeon, be it the author or someone else, might have at least some guide by which to orient himself in the much changed anatomy. The author would like to point out that there are now two openings through which small intestinal herniation could take place. The upper one, the large new communication between the lesser and greater cavities formed by the blind end of the transverse colon, transverse mesocolon in back and gastrocolic omentum in front. There is no mobile organ within this upper space (lesser sac) which could possibly herniate from within out, but one might conceive the possibility of small gut in the major cavity herniating from without through this opening into the lesser sac. To the author it seems probable that with no increased pressure from within the edge of transverse mesocolon and the edge of the gastrocolic omentum will probably adhere and obliterate the opening. The lower opening is bounded anteriorly from below upward by the posterior surface of the rectum and rectosigmoid from the point of extraperitonealiza-

with two rows of running catgut sutures, and Michel clips were placed on the skin. No drain was placed in the peritoneal cavity.

After the operation, the patient seemed to be rather shocked, due to the extensive manipulation. However, her condition soon became very satisfactory. The vomiting ceased completely. On the following day the patient felt no more pain; the abdomen was slightly tender but, nevertheless, soft. The clips were removed on the eighth postoperative day. Healing was by first intention. The patient left the hospital twelve days after admission and was perfectly well until thirteen days after discharge, at which time she again came to the hospital, complaining of the same excruciating pains accompanied by vomiting. She was agitated. Her pulse rate was 104 beats per minute, temperature 36.6°C., and blood pressure 96 systolic and 60 diastolic. The abdomen was distended and tender and slightly rigid on palpation, especially on the lower half. The patient had not had a bowel movement for forty-eight hours, but shortly after admission had one and passed considerable gas. The pain and muscular rigidity subsided completely two hours later. After eight days of medical care and observation she was dismissed, perfectly well.

#### GENERAL CONSIDERATIONS

*Incidence.* A survey of the literature on the subject was made and twenty-seven papers were collected, all but two of which were published between 1920 and 1941. These showed very few successful cases. As to the incidence, one can say that it is very rare. MacClure, in 1935, collected thirty-seven cases from the medical literature. It is possible that the number of cases is greater, for some authors are not precise in giving a title to their reports. One should always specify that the case was of a volvulus of the *entire* small intestine if it happens to be so, and not simply say volvulus of the small intestine. In the Massachusetts General Hospital, in the space of twenty years, there were 239 cases of intestinal obstruction; twenty-five of them were due to volvulus, only ten of which were of the small intestine. Among these ten cases out of the total of 239, there was only one case in which the volvulus in-

cluded the whole small intestine with torsion of the entire mesentery.

*Age.* As to age, one can say that volvulus of the entire small intestine is more common in adult life (average forty-five years); unless statistics are false, owing to the fact that many children die without a correct diagnosis.

*Sex.* There is, according to all statistics, a greater percentage of men who develop this condition than women.

*Degree of Torsion.* In most cases the degree of torsion is not more than 180°. The rotation is clockwise in the greater number of cases. Some authors, however, do not mention this detail. Others, on the other hand, use different terminology, such as "rotation from left to right." This is very misleading because one never can tell whether one is referring to the left of the patient or that of the surgeon.

*Etiology.* Many etiological factors have been suggested, such as structural changes; adhesions, congenital or those due to previous peritonitis; old scar formation or chronic mesenteritis; former operations (bands, adhesions); mesenteric cysts; habitual constipation; chronic intestinal stasis; long mesenteries with a longer range of motion during peristalsis; congenital development of mesenteric pedicle in the shortening of its vertical attachment to the posterior abdominal wall; short attachment of the mesenteric root; non-rotation of the common mesentery and large and small intestine during their embryologic development, which normally takes place during the fourth month of fetal life. There are predisposing factors, such as the presence of hernias. The *exciting cause* may be a blow on the abdomen, heavy lifting, or even disorderly peristaltic action. It has been said that the vegetarian races, such as the Slavs and Scandinavians, who have bulky diets, are apt to have atony of the intestines and consequent chronic distention, which predisposes to twisting of the gut. Other authors think that perhaps the twisting is provoked by the stimulating effect that the cellulose from several vege-



# VOLVULUS OF THE ENTIRE SMALL INTESTINE AND ITS MESENTERY

## CASE REPORT

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**V**OLVULUS of the entire small intestine is a type of intestinal obstruction that has many peculiar surgical aspects. The number of successfully operated patients is exceedingly rare.

## CASE REPORT

A white, married female, twenty-eight years of age, was admitted to the Getulio Vargas Hospital, complaining of intense intermittent colicky abdominal pain of three days' duration. Vomiting began shortly after the onset of pain and was progressively more frequent, finally becoming practically continuous and consisting only of liquid non-fecal material. Since the beginning of pain there had been no bowel movements.

The patient had been married when she was twenty-two years old and since had had a yellowish vaginal discharge, for which treatment had been incomplete. She had always had trouble with constipation. Appendectomy had been performed twelve years previously.

On admission the patient was acutely ill. Her temperature was 38°C., her pulse rate 104 beats per minute, and her blood pressure 110 systolic and 60 diastolic. Inspection of the abdomen revealed the absence of respiratory movements and a slight bulging at the umbilical area. There was an irregular operative scar over the abdominal wall. Percussion was painful and showed tympany over the whole abdomen. Liver dullness was absent. Palpation was especially painful around the umbilical area but there was no rigidity. The patient had intense rebound tenderness, particularly over the mid-abdomen. Nothing abnormal was found at the hernial orifices. A bimanual vaginal examination revealed tenderness of the left fornix. Examination of the respiratory and cardiovascular systems was essentially negative. A flat plate of the abdomen was reported as follows:

"Dilated loops of small intestine. Absence of fluid levels. Partial obstruction high up in the small intestine. Adhesions?"

A preoperative diagnosis was made of mechanical ileus, high up in the small intestine, probably due to an old postoperative band. Immediate operation was undertaken, under spinal anesthesia, after a brief preoperative treatment directed to correct the fluid loss and electrolytic balance.

A medial infra-umbilical incision was made. In the peritoneal cavity there was a small amount of serous fluid present. There were numerous omentovisceral and viscerovisceral adhesions. All the loops of the small intestine seemed to be equally distended and had a purplish blue color. Since the cause of the obstruction was not immediately found, a thorough exploration of the peritoneal cavity was made, beginning with the small intestine, which was examined from above downward, toward the cecum. All the loops were distended and had the same purplish blue color. In the course of this examination a thick and tense band was found, holding down a fixed, distended loop of small bowel. By the side of this loop, and also emerging from below this band, there was another loop of small intestine of normal color and diameter. Traction on this second loop brought out with ease several other loops of ileum. The incision was then enlarged and a massive evisceration of the whole small intestine was done in order to examine with greater ease and visibility this peculiar and inexplicable condition. It was then seen that the thick "band" was the mesentery itself twisted once round in a clockwise direction. Detorsion was effected by rotating the eviscerated mass of small intestine counterclockwise. The mesentery was found to be extremely long. The small intestine soon regained its normal color and contractility with the help of warm physiologic solution. The abdomen was closed

of bowel. One has a fairly normal color and diameter, the other, right next to it, is distended and congested. Tesson, with this finding, did not hesitate to make the diagnosis in his successful case presented by Delbet at the Surgical Society of Paris meeting in 1907.

The best operative procedure should be simple detorsion, by rotation *en masse* in the opposite direction of the twist. Simple detorsion is all that has been found necessary. Folding and shortening of the mesentery has been abandoned and considered useless. Resection, of course, has to be done if, by any chance, the vitality of any segment is compromised.

Death, due to lack of operative treatment or operation performed too late, is brought about by injury to the sympathetic plexus from strangulation, absorption of toxins from the peritonitis, and physico-chemical changes in the blood. Mortality after forty-eight hours is 75 per cent.

#### SUMMARY

A twenty-eight year old white female was admitted to the hospital with intense intermittent colicky abdominal pain of three days' duration, followed by profuse vomiting. Physical examination revealed bulging around the umbilical area, an appendectomy scar, visible persitalsis, and rebound tenderness. On operation all loops of the small bowel were found to be distended and bluish. Massive evisceration of the small intestine revealed a thick, tense band that was found to be the mesentery itself twisted in a clockwise direction and holding down two loops of small bowel, one fixed, distended, and bluish and another normal in diameter and color. Simple detorsion was performed and the patient's recovery was uneventful.

From the preceding report of a case and general considerations, the following conclusions may be made: (1) The case reported is that of a very infrequent type of volvulus. Patients successfully operated upon are exceedingly rare. (2) Precise clinical diagnosis is impossible. The twist

of the *whole* mesentery can be detected only at exploration. Before exploration, one can make only the diagnosis of acute mechanical intestinal obstruction of the strangulating type. (3) Even at exploration, the precise diagnosis can be difficult to make. It has been overlooked by many experienced surgeons. (4) Early operation is the most important factor for success. (5) All the coils of small bowel are found to be distended and showing vascular changes. The cecum is found empty. (6) The twisted mesentery can be detected only after evisceration *en masse*. (7) The twisted mesentery presents itself as a thick and tense band underneath which two loops pass, one distended and bluish and another with normal color and diameter. (8) Treatment should consist of simple detorsion with minimum trauma and in minimum time. (9) Without operative treatment, mortality is 100 per cent. (10) Authors must be precise in the reporting of their cases. One should mention torsion of the *entire* small intestine whenever the case happens to be so.

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tables has in the peristaltic actions. Cases of volvulus in these countries are more common. Active purgation may also bring about volvulus.

**Symptoms.** There are no special and characteristic symptoms. The clinical picture is that of an acute mechanical intestinal obstruction. There is sometimes previous constipation or abdominal discomfort, and at other times no previous history. The abdominal bulging varies in degree. When there is an internal strangulated intestinal loop, there is generally a great and pronounced distention at a certain point (von Wahl). The intestinal coils situated above the obstacle are emptied by vomiting, those below are also found empty. When, however, the torsion includes the entire small intestine, all the loops are uniformly distended. This distention varies in degree on clinical examination, according to the lesser or greater resistance of the belly wall, which tends to hold back the tension of the intestinal gases.

Some authors mention the fact that there is no fecal vomiting in this type of ileus. That is a negative finding of little importance. As a matter of fact, the diagnosis of ileus should be made long before this ominous symptom ever occurs.

The intensity of the abdominal pain depends upon the rapidity of torsion, the extent of the volvulus, and the tightness of the twist.

The precise diagnosis of volvulus of the entire small intestine is clinically impossible. One can be satisfied with the diagnosis of mechanical obstruction of the small bowel of the strangulating type, which at times may not be without difficulty. Surgery should be performed without delay. Practically all successful cases are those in which the patients have been operated upon within the first forty-eight hours. Without operation, the number of deaths is 100 per cent.

**Diagnostic Operative Findings.** The diagnosis on the operating table is not as easy as one would imagine. In the case of partial volvulus, the disorder can be found

easily enough; but in the case of a torsion of the entire small intestine, anatomical relations are so modified, and the intestinal coils are disposed in such a fashion that even an operative diagnosis can make itself extremely difficult, especially when one is not aware of the existence of this infrequent type of obstruction. Mignon, Delore, Kirmisson, and Debré were unable to discover the cause of obstruction in their cases and simply closed the abdomen without re-establishing the fecal course. Needless to say, they were all fatal cases. Delbet himself confessed that in his first case he also could not figure out where the disorder was, and he also closed the abdomen without removing the obstruction. It is quite possible that many cases have passed without the correct postmortem diagnosis, which can be made only if the autopsy be performed in a correct manner, that is, one has to examine the intestine *in situ* as if one were operating.

Delbet, with the experience gained in his first case, made the operative diagnosis promptly in his second case. Although the great majority of surgeons have never seen a case, we think that they could very well make the diagnosis with the mere knowledge of the existence of this rare kind of volvulus.

On opening the peritoneal cavity, one is apt to find serous fluid. It is a common finding in every volvulus. All the intestinal coils show themselves uniformly distended and with evidence of vascular changes; they appear with a purplish blue color. Later on, more serious complications may be encountered. The twist may be tight and obstruct completely the mesenteric blood vessels, with a menace to the vitality of the whole small intestine. Gangrene may set in. Once the abdomen is opened, the intestinal loops tend to eviscerate spontaneously, due to the gaseous distention inside them. The cecum is found to be empty. The twisted mesentery can be detected only after evisceration *en masse*. One then encounters a thick and tense "band," underneath which pass two loops

# SURGICAL REMOVAL OF HUGE RETROPERITONEAL EPITHELIAL CYST\*

WITH ADENOCARCINOMA ORIGINATING IN THE LINING

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**H**UGE multilocular retroperitoneal cysts are of uncommon occurrence but, when they do occur, their successful removal presents a major surgical problem. The case studied by the authors was of interest from this standpoint and, in addition, presented unusual gross and histologic findings, difficulties in classification, prognosis and pathogenesis, and showed early malignant degeneration of the lining epithelium.

Cysts are classified in general by William Boyd<sup>1</sup> as retention cysts, cysts of new formation, cysts of developmental origin, and parasitic cysts. Non-parasitic cysts are observed in persons of all ages. Large single or multiple cysts from retention of bile are occasionally observed. Bayer<sup>2</sup> reported a cyst containing 13.5 pints of fluid; Aldous<sup>3</sup> 12 pints; North<sup>4</sup> 5 pints; and Doran<sup>5</sup> 2.5 pints. In each of the foregoing cases the cyst wall was of fibrous tissue with numerous bile ducts embedded in it. The lining was of cubical, cylindrical, or flat cells with desquamation of epithelium. Zahn<sup>6</sup> collected fourteen cases of cysts lined by ciliated epithelium. According to Moschkowitz,<sup>7</sup> this suggests an origin from congenitally misplaced aberrant bile ducts. Stoesser<sup>8</sup> described a solitary, non-parasitic cyst of the liver in a newborn, which was so large that it prevented normal delivery of the child. Ottenheimer<sup>9</sup> states that Moschkowitz reviewed the literature in 1906 and found eighty-five cases of solitary, nonparasitic cysts of the liver. The former, in his review

of the literature, 1900-1927, reported eighty-one other cases. Orr<sup>10</sup> described a strangulated, non-parasitic cyst of the liver. He analyzed seventy-five cases from the literature and found that the correct preoperative diagnosis was made in only three instances. The condition is usually diagnosed as hydrops of the gallbladder, ovarian cyst, pancreatic cyst, or mesenteric cyst. Parry<sup>11</sup> completely dissected out a congenital cyst of the liver, covered the raw surface with fine catgut sutures, and closed the abdomen without drainage. Shattuch<sup>12</sup> described a cyst, with many ducts and minute cysts in the wall, containing a gallon of clear fluid. He interpreted this as an adenomatous cyst. Keen<sup>13</sup> successfully removed an 113 Gm., true multilocular cystadenoma made up of many cavities lined by cylindrical cells and supported by fibromuscular tissue. Siegmund<sup>14</sup> reported an isolated cystic mass forming a large part of the liver in which there were many areas suggestive of new growth of cubical cells. Ochsner<sup>15</sup> reported an unilocular, non-parasitic cyst attached to the undersurface edge and upper surface of the right lobe of the liver, lined with low columnar epithelium and filled with 3.5 gallons of murky fluid.

## CASE REPORT

C. F., a twenty-three year old white male was admitted to the Laird Memorial Hospital on February 13, 1941, complaining of dull epigastric pain. The patient stated that for as long as he could remember he had had

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## Barbosa—Volvulus

JUNE, 1944

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FIG. 3.



FIG. 4.



FIG. 5.

FIG. 3. Section of cyst wall lined with flat epithelial cells. Microphotograph  $\times 265$ , U. S. Army Medical Museum, Neg. No. 73129, Accession No. 73089.

FIG. 4. Cyst lined with cylindrical epithelium in fibrous wall of larger cystic structure. Note resemblance to bile duct formation. Microphotograph  $\times 265$ , U. S. Army Medical Museum, Neg. No. 73127. Accession No. 73089.

FIG. 5. Note infiltration of inner part of cyst wall by atypical epithelial cells. Microphotograph  $\times 265$ , U. S. Army Medical Museum, Neg. No. 73131. Accession No. 73089.

extremely heavy upper abdominal muscles. During the past few weeks there had been some pain in the epigastrium, which originated

by the mass. By intravenous pyelograms the right kidney was found to be pushed to the left.

Operation was performed February 18, 1941,

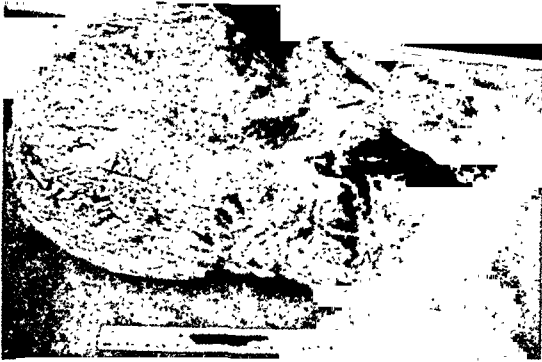


FIG. 1. Huge retroperitoneal cyst; surgical specimen.



FIG. 2. Transection of cyst showing multi-locular structure, and at the left cut surface of attached liver tissue.

just above the umbilicus and radiated to the right supraclavicular area. The pain was accentuated by deep inspiration. He had noted some increase in the size of the epigastrium and a slight decrease in strength. There had been occasional frequency of urination but no history of hematuria, pyuria or other urinary symptoms. Recurrent attacks of sore throat and tonsillitis had been present for five years previous to tonsillectomy one year ago. He had had uncomplicated measles, pertussis, chickenpox, and diphtheria during childhood. There was no familial history of tuberculosis, cancer, epilepsy, diabetes, or insanity. Physical examination revealed a well developed and nourished white male, lying quietly in bed and not appearing acutely ill. The temperature was 98.0°F., respiratory rate 26, pulse rate 86, and blood pressure 136 systolic and 78 diastolic. The heart and lungs were normal. A tumor mass was palpated in the right abdomen extending from the costal margin to the crest of the ilium and just across the midline. The tumor mass was cystic to palpation and dull to percussion.

The urinalysis was negative. The erythrocyte count was 4,890,000, hemoglobin 71 per cent, total leucocyte count 11,000, polynucleophils 81 per cent, lymphocytes 18 per cent, and monocytes 1 per cent. Sedimentation rate for the first hour was 74 mm. and for the second hour 105 mm., by the method of Westergren. Urea nitrogen was 9.0 mg. per 100 cc. of blood. Roentgenological examination showed the transverse colon displaced toward the left

for removal of a large retroperitoneal tumor. A long curved incision was made, extending from the costal margin laterally to the right rectus muscle to the anterior iliac spine. The abdominal cavity contained a small amount of serous fluid. A huge, gray, glistening tumor presented through the wound, covered by the peritoneum of the posterior wall of the abdomen, except for the attachment of the superior pole to the posterior surface of the right lobe of the liver. The liver had been pushed into the left upper quadrant of the abdomen, and the right kidney was rotated to the left and situated to the left of the spinal column. The tumor was brought through the wound with some difficulty. At this time the patient's blood pressure dropped and the pulse rate became extremely rapid. The tumor was carefully separated from the liver by sharp dissection and completely removed without rupture or drainage of the contents. The large raw surface over the posterior portion of the right lobe of the liver and posterior peritoneal incision were covered and closed with fine catgut sutures. After removal of the tumor the right kidney fell back into its normal position.

The postoperative course was rather stormy, with temperature elevation to 104.0°F., and formation of an abscess in the right lower quadrant of the abdominal wall. This was successfully drained by incision. Bacteriological study of the thin, gray pus disclosed streptococci. Sulfanilamide was administered. A second abscess, localizing in the cul-de-sac, was

cm. These cavities were numerous and measured on the average from 0.5 to 8.0 cm. in diameter, but no communication could be

on dense hyalin tissue, and extending into the fibrous stroma of the capsule separated by hyalin and connective tissue fibers, giving a

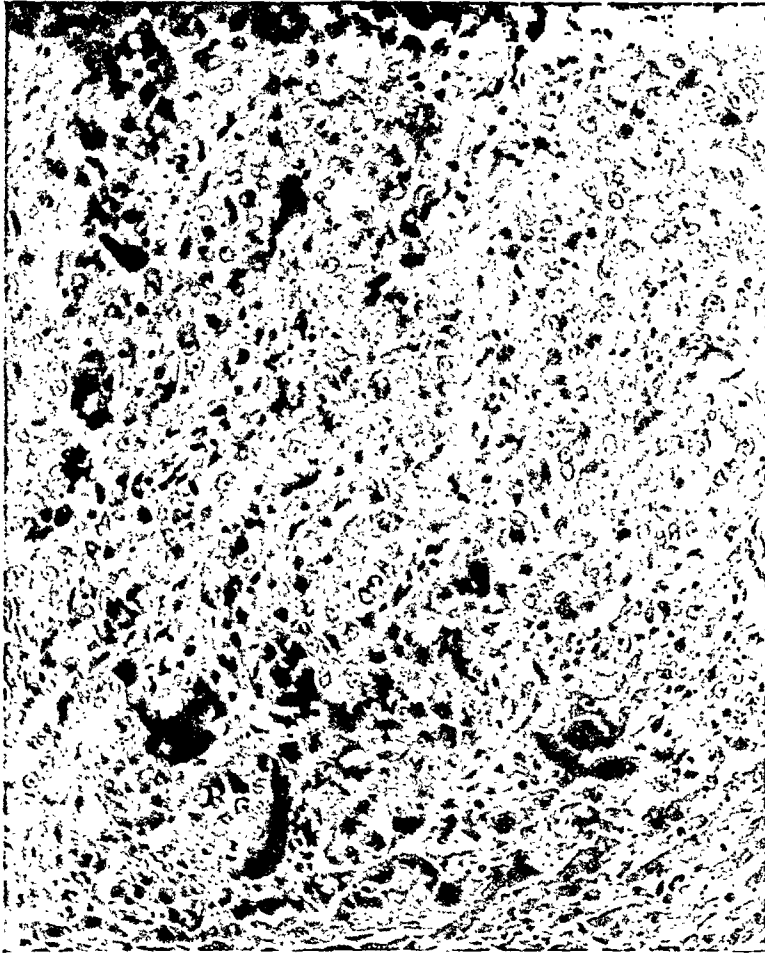


FIG. 7. Metastatic adenocarcinoma in the liver. Microphotograph  
× 400.

demonstrated between them. The capsule of the cyst and the cyst walls measured from 4.0 to 8.0 mm. in thickness and were made up of dense fibrous connective tissue. The cysts were lined by a glistening grayish membrane, smooth over most areas, but somewhat roughened and ulcerated in a few places. There was no evidence of coccidiosis. (Figs. 1 and 2.)

Microscopical examination of slides revealed the cyst lined largely by low, medium and high columnar epithelium, in a few areas drawn into low papillary folds projecting into the lumen. The nuclei were oval and situated at the base of the cells with the long axis perpendicular to them. The cytoplasm was pinkish and contained vacuoles. In other areas the cells appeared stretched and were of cuboidal or flattened epithelium. In a few areas the lining epithelial cells formed elongated layers resting

laminated appearance. There were mononuclear cells with small nuclei and small amounts of fibrin adherent over the rough ulcerated areas. The wall of the cyst was made up of areas of smooth muscle with numerous small ducts lined with columnar epithelium with structure similar to that of small bile ducts. The ducts varied in size. Some of them had scarcely any lumen while others formed saccular spaces. The fibrous stroma of the wall contained fibroblasts and was infiltrated with scattered polymorphonuclear neutrophilic leucocytes, small lymphocytes, and mononuclear cells. There were small aggregations of lymphocytes in some areas. A study of the sections from the yellowish-red, rounded area of tissue adherent to the capsule of the cyst disclosed it to be made up of liver tissue densely adherent to this capsule. It contained a small adenomatous nodule of hepatic



treated in the same manner. Postoperative roentgenological examination by Graham-Cole method showed the gallbladder clearly visual-

erythrocytes 3,050,000, color index 0.75, hemoglobin 45 per cent, total leucocyte count 44,000, differential count 94 per cent polymorpho-



FIG. 6. Metastatic adenocarcinoma in the liver with subacute hepatitis. Microphotograph  $\times 75$ .

ized, long, narrow, and apparently fixed to the liver in a transverse position with the tip bent upward and laterally. By intravenous pyelograms the kidneys were found to be normal in shape, size and position.

The patient was discharged from the hospital, apparently in good condition. He returned to his usual work and worked continuously as a laborer during a period of thirty-five days. Five months after the removal of the cyst he was readmitted, complaining of dull, aching pain in the left upper quadrant of the abdomen. His temperature was  $100.8^{\circ}\text{F}$ . and pulse rate 88. There was tenderness on palpation high in the left upper quadrant of the abdomen but no masses were palpated. His course in the hospital was febrile and retrograde with a spiking temperature, ranging between  $101.0^{\circ}\text{F}$ . and  $104.6^{\circ}\text{F}$ . Hematological survey at this time disclosed

nuclears and 6 per cent lymphocytes. His condition became more critical in spite of repeated blood transfusions, and the temperature was subnormal for several days preceding death, nine months after discovery of the tumor.

The pathological specimen was an oval, whitish-red, cystic tumor mass, removed intact, which weighed 9,080 Gm. and measured 37.0 by 27.0 by 15.0 cm. The capsule was fibrous and smooth except for a roughened area, 14.0 by 18.0 cm., corresponding to the attachment to the liver. This area contained a pale, firm, yellowish-red, oval mass, 3.0 cm. in length and 2.5 cm. in diameter, with a smooth surface, attached to the capsule of the cyst by dense fibrous adhesions. The cyst was multilocular and contained 7,540 cc. of pale brownish fluid with a specific gravity of 1.004. The largest of the cyst cavities measured 29.0 by 26.0 by 12.0

probably derived from the aberrant remains of the Wolffian body. Another possible origin of this cyst which seems more probable from its structure is that it developed from congenitally misplaced, extrahepatic, aberrant bile ducts. According to Moschkowitz, such ducts are embryonal rests found in the course of development of the liver. The lining of cuboidal medium and tall columnar epithelium, smooth muscle in the fibrous cyst wall, the intimate attachment to the liver, and the presence of acinar structure in the wall, support this view.

#### SUMMARY

1. An unusual case of huge multilocular retroperitoneal cyst is reported with a review of the literature.

2. The most probable origin of this cyst is from congenitally misplaced, extrahepatic, aberrant bile ducts.

3. Such structures may give rise to neoplasms through malignant transformation of the cells in the wall or lining of the cysts.

4. Large cysts are a hazard to the life of the patient both from the danger of

rupture and from the standpoint of a focus of chronic inflammation.

5. Complete surgical removal without rupture of the cyst is highly desirable both from the standpoint of the wound contamination and because of the possibility that the cyst lining or wall may be the site of a malignant tumor.

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cords and other areas of compressed hepatic cords surrounded by fibrous connective tissue proliferation and was infiltrated with exudative cells, chiefly polymorphonuclear neutrophilic leucocytes, lymphocytes, and histiocytes, containing brownish pigment. In other areas the liver presented a smooth resected surface, densely adherent to the cyst wall. In the part of the liver adjacent to the cyst wall the trabeculae were widened and contained fibrous connective tissue infiltrated with exudative cells. In focal areas the epithelial lining of the cyst wall was replaced by proliferating atypical epithelial cells, which formed elongated cords parallel to the cyst wall, and infiltrated the inner one-half of the wall with imperfect alveolar segments. The nuclei of the cells were hyperchromatic with large nucleoli. Occasional mitotic figures were observed. A careful search was made in the fluid from the cyst and in the cyst wall for the hooklets of *taenia echinococcus*. None were found.

**Histopathological Diagnoses:** Huge multilocular, retroperitoneal epithelial cyst; aberrant liver tissue adherent to cyst wall with pressure atrophy and chronic proliferative and exudative inflammation; focal areas of very early adenocarcinoma, grade 1, originating from epithelial lining of cyst. (Figs. 3, 4 and 5.)

Necropsy examination disclosed 1,000 cc. of clear yellow fluid in the peritoneal cavity. The liver weighed 4,800 Gm. and extended to the level of the umbilicus. There were numerous whitish-yellow nodules, 0.3 to 3.0 cm. in diameter, throughout the liver. The gall-bladder and bile ducts were normal. The spleen was pale red, soft, and weighed 425 Gm. The kidneys were normal. The gastrohepatic mesenteric lymph nodes were moderately enlarged, gray and infiltrated with tumor tissue. There were several flattened whitish-yellow tumor nodules in the visceral pleura of both lungs, measuring 0.5 to 0.8 cm. in diameter. The lung surface was deep red and congested. The myocardium was deep brown and the heart weighed 221 Gm. There was no free fluid in the pleural cavities. Careful examination of all the organs did not disclose any primary source of the tumor other than the cyst previously removed.

Microscopic examination of sections from the liver showed tumor nodules fairly sharply demarcated from the liver tissue, made up of atypical epithelial cells in an imperfect alveolar arrangement, the formations suggestive of

small ducts and acini. The nuclei were rounded and oval with a hyperchromatic vesicular pattern. No mitotic figures were observed. The pleura and mesenteric lymph nodes contained similar nodular formations of atypical epithelial cells. Additional findings were subacute hepatitis, bronchopneumonia, and chronic splenitis. The anatomical diagnosis was: Adenocarcinoma, primary, epithelial lining of retroperitoneal epithelial cyst, with metastasis into liver, mesenteric lymph nodes and pleura.

#### COMMENTS

From the gross and microscopic features it was evident that we were dealing with a huge multilocular cyst filled with clear, pale brown fluid, with a rather thick wall made up of dense fibrous connective tissue containing small areas of smooth muscle and acinar formations of columnar epithelium suggestive of small bile ducts. The cyst was lined in some areas with fairly tall columnar epithelium and in others with cuboidal or flat epithelial cells. There appeared to be a very early malignant degeneration in some areas of the lining epithelium with a downgrowth of cord-like formations and imperfect alveoli of atypical dark-staining epithelial cells. The cyst was attached to the right posterior lobe of the liver over a wide area with the bulk of the mass in a right retroperitoneal position, pushing the right kidney across the midline of the body. The cyst wall contained areas of chronic inflammation which may account for the stormy, febrile postoperative course and multiple abscess formation. From the appearance of the cyst lining, wall, contents and position this did not appear to be a chylous, enteric, or dermoid cyst of the peritoneum, mesentery, or omentum.

Many cysts with single or multilocular structure, involving the mesentery and adjacent regions, may belong to the group of intraperitoneal cysts of nephrogenic origin. The contents of this type of cyst are brownish, serous, pseudomucinous fluid. The wall is composed of fibrous tissue and the lining of high cylindrical or cuboidal glandular epithelium. These cysts are

inhibitory influences of the sympathetics completely to include all of these nerves.

Adamson and Aird<sup>7</sup> proposed experimental evidence performed on cats to support the neurogenic theory. Resection of the parasympathetics to the distal colon produced a progressive megacolon.

Burrows<sup>8</sup> noted that following injection of silica into the mesentery of the cecum of rats there developed a marked enlargement of the colon. It was assumed that this substance came in contact with the sympathetics and not the parasympathetics and produced a stimulation of the sympathetic nerves.

The diagnosis of this condition is accomplished both in the acquired and congenital forms without much difficulty. In the congenital form the enlargement of the abdomen is present from birth or soon thereafter. There is always considerable difficulty in having a normal bowel movement.

Development may be progressive, associated with marked atony of the large intestine. Roentgenograms should determine the presence of atresias, valves, tumors, inflammations, or other organic disease. Blocking the sympathetics by the administration of spinal anesthesia readily demonstrates the existence of a functional muscular atony (Stabins<sup>9</sup>). This temporarily interrupts the reflex and allows the motor activity to occur with an improvement in motility. This, is, therefore, beneficial preoperatively to determine the results before section of the lumbar sympathetics.

Prior to 1925 all therapy was directed toward the local condition. At first, diets, enema and colonic irrigations were tried with indifferent success. Many forms of exercise and binders were used with very little benefit. More recently, with knowledge of the chemical changes that occur in the synapses of the automatic nerves, acetylcholine and similar drugs have been advocated. Puitritin, pilocarpine, physostigmin, prostigmin, parathomone, arsenic, and iron have been given.

Klingman<sup>10</sup> states that the toxic action of the various drugs used to remove the

cholinergic substance within the nerves limits their usefulness and benefits. Syntropan<sup>10</sup> was advocated because it had the



FIG. 1. Preoperative roentgenogram of the abdomen which shows the megacolon.

action of atrophine to stop this cholinergic action but did not have its toxic and drying effects. Prostigmin and physostigmin intensify the action of acetylcholine through prolongation of its activity by preventing the cholin esterase from destroying the acetylcholine. This is accomplished in the absence of disturbance of the rectosigmoidal apparatus. It is concluded that selective drug therapy has proved effective when neurogenic imbalance has been established because of defective inhibitions or motor functions of the parasympathetic system.

de Takats<sup>11,12</sup> used various drugs to lessen the inhibitory influence of the sympathetics and to stimulate the parasympathetics to increase peristalsis and to relax the sphincters. When there is no improvement after three years of conservative treatment, surgery is advised.

Since Wade in 1925 advocated sympathectomy many forms of surgical therapy have been used. This, in part, may be due to lack of knowledge concerning the sympathetic and parasympathetics. Telford and Stafford<sup>13</sup> attempted to clarify the knowledge of these structures. There is

# MEGACOLON ASSOCIATED WITH VOLVULUS OF TRANSVERSE COLON\*

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THE first description of megacolon is usually ascribed to Hirschsprung in 1866 and sometimes bears his name. However, it has been shown that this condition had previously been recognized by Mya and others. Finney,<sup>1</sup> in 1908, reviewed the condition and described the pathological aspects but did not contribute an etiology of the disease.

An agreement is now held as to the general aspects. There is usually a uniformly enlarged, dilated colon. However, in some only segments of the colon are involved. It is within and associated with the segmental form that mechanical obstruction such as volvulus may occur. The dilatation is thought to be a progressive one in which there eventually develops a loss of motor activity of the intestine. The musculature and the remainder of the intestinal wall develop hypertrophic changes which occur in spite of continued dilatation. There is not infrequently found an associated obstructive lesion within the wall of the gut which accounts for the acquired forms. These obstructions may either be due to an inflammatory stricture or a long-standing annular malignancy of the lower large intestine.

Fenwick,<sup>2</sup> in 1900, proposed the developmental theory with associated dilatation and hypertrophy of the colon. Following this there were many proponents of the mechanical idea that the condition was associated with atresias, valves in the rectum and anus, which produced spasms and were followed by dilatation of the colon and elongation of the mesentery.

In 1895, Langley and Anderson<sup>3</sup> proposed the first possible etiological factors relative to the present knowledge of the disease.

It was noted that stimulation of the lumbar sympathetic ganglia caused an inhibition of peristalsis with a dilatation of the colon. Prior to this period the lesion was thought to be due to inflammation of the colon, enlargement of the colon, actual mechanical obstructions, and congenital aplasia of the muscular tissue.

The neurogenic theory is based on definite physiological reasoning. It is assumed that there is a reflex spasm of the internal sphincter in the absence of a gross obstructive lesion. There is a relaxation of the internal sphincter and a paralysis of the bowel. This is tenable with the knowledge that stimulation of the sympathetics causes a contraction of the bladder and rectum and a dilatation of the walls of these viscera. It is assumed that in normal health these structures are functioning harmoniously in allowing the filling and emptying of the viscera. Depression of the parasympathetic or a stimulation of the sympathetic systems would produce a megacolon.

Wade and Royle,<sup>4</sup> in 1925, performed a lumbar sympathectomy for megacolon which was soon followed by others.<sup>5</sup> Adson and Bergen<sup>6</sup> made a distinction between the types of the disease and were particularly interested in the control of constipation in the atonic forms. A bilateral resection of the first and second lumbar ganglia and the splanchnic nerves was done. A resection of the superior and inferior mesenteric ganglia and presacral nerves were denervated only in the distal half of colon. The cephalad portion is controlled by the postganglionic fibers from the celiac plexus and mesenteric ganglia. It is, therefore, necessary in order to remove the

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was noted. On March 22, 1942, the pains became more severe and distention was more marked. The same measures as had been pre-

The convalescence from this procedure was uneventful. The clamp on the proximal side of the colon was removed on the fourth day. A



FIG. 3. Shows barium enema in the lower segment of colon after colostomy. The point of constriction is noted below the colostomy.

viously used were instituted, but the patient became progressively worse. When seen on March 27, 1942, the pain was of the peristaltic type. There was marked dehydration and the abdomen was tremendously distended.

On March 28, 1942, under spinal anesthesia, a long upper left rectus incision was made. On opening the abdomen the large intestines were enormously distended. The transverse colon was rotated near the splenic flexure one complete time. There was an old adhesion which extended horizontally across to the transverse mesocolon. This was released and the volvulus untwisted. Due to the extreme thickening and friability of the gut, a resection of this portion was done. The ascending colon was sutured to the descending colon and the mesocolon mobilized. The clamps were placed on the ascending colon and the upper descending colon and the intervening segment was excised. The ends of the gut were brought on the abdominal wall with the clamps in place. The abdomen was then closed around the proximal and distal stomata. The patient reacted very well from this procedure. He was given 500 cc. of .8 per cent sulfanilamide subcutaneously and 200 cc. of .8 per cent sulfanilamide were given subcutaneously every eight hours.



FIG. 4. Photograph of the opened descending colon, noting the site of the intrinsic annular inflammatory stricture.

crushing clamp was placed on the spur of the colostomy, which cut through, but no feces were passed normally. The patient was allowed to leave the hospital using a colostomy bag. He was readmitted to the hospital July 15, 1942, for closure of the colostomy. After readmission a barium enema revealed an enormous dilatation of the sigmoid colon. About three inches below the site of the colostomy stoma an annular constriction was noted, through which no barium could escape.

On July 18, 1942, an elliptical incision was made around the colostomy, which had been temporarily closed. The peritoneal cavity was opened and the site of the colostomy delivered. About two inches below the opening of the colostomy the constriction in the sigmoid was noted. Below this point the gut was thickened and dilated. The remaining portion of the ascending colon, cecum and appendix were dilated and hypertrophied. Due to the extensiveness of the disease and the obstruction, the remaining portion of the colon was resected. A side-to-side anastomosis of the rectum and terminal ileum was done. Nine Gm. of sulfanilamide was placed in the abdominal cavity, which was closed without drainage. Convalescence was uninterrupted. On the seventh day postoperatively the patient passed a soft liquid stool and had soft bowel movements thereafter. Convalescence continued normally and the patient was dismissed from the hospital August 12, 1942.

Histological examination of the resected colon and the site of the constriction revealed

yet considerable vagueness in regard to the parasympathetic arrangement.

The sympathetic cord is supposed to be

taken. This report is concerned with a problem of this nature. With the use of sulfonamides, particularly succinyl sulfa-



FIG. 2. Resected specimen of transverse colon which constituted that part of the volvulus.

derived from segments from the second thoracic to the third lumbar. Therefore, wide ranges of operative procedure are performed; perivascular sympathetic or aortic plexus and inferior mesenteric sympathectomies, lumbar sympathectomy, ramisectomy of the medially directed rami, and resection of the presacral nerves. The use of the latter procedure has the disadvantage of producing the loss of ejaculatory functions. Weeks<sup>14</sup> advocates, therefore, in younger individuals ganglionectomy, and some type of resection in older individuals.

In the presence of gross obstructive pathological lesions surgical care must be directed to the local problem.<sup>15</sup> Dilatations of the anal sphincter, correction of fissures, removal of valves and atresias should be beneficial where there is no derangement of the autonomic nervous system.

The size and mobility of a megacolon may allow a volvulus to occur. It is for this reason primarily that resections of the colon, either in part or totally, are under-

thiazole, resection of the colon can be accomplished with less mortality and morbidity. If the megacolon becomes acutely obstructed, operative treatment is imperative; and the protective benefit of this form of chemotherapy cannot be obtained at the time of operation.

#### CASE REPORT

J. B., age twenty-two, a white, male, gave a history of having a marked enlargement of the abdomen all his life. He had no difficulty until 1939, when he was admitted to Emory University Hospital by Dr. William H. Trimble. On admission there was marked abdominal pain, nausea, vomiting and distention. The treatment consisted of mecolyl bromide, hot fomentations, colonic irrigations and supportive measures. Under this treatment he improved but remained in the hospital for several weeks. He did fairly well until March 2, 1942, when he began to have cramp-like pains in the abdomen, marked distention, nausea and vomiting. A Miller-Abbott tube was inserted, fluids were given intravenously, and some improvement

# RUPTURED MUCOCELE OF THE APPENDIX WITH PSEUDOMYXOMA PERITONEI\*

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IN a seven-year review of the pathological records of St. Vincent's Hospital, the occurrence of mucocele appeared four times in 3,087 appendectomies, and once in 760 adult autopsies, thus giving an incidence of 5 or .13 per cent in a total of 3,847 cases. In a six and one-half-year review of the American literature, beginning July 1936, cases of mucocele of the appendix were sporadically reported. The number of reported cases gathered by various authors is now approximately 500. During this six and one-half-year period I have been able to gather only six reported cases of ruptured mucocele. Waugh and Findley,<sup>1</sup> Doyle,<sup>2</sup> Morgan,<sup>3</sup> Chaffee and Le Grand,<sup>4</sup> Hall<sup>5</sup> and Willcutts and Henkel<sup>6</sup> have each reported one case of ruptured mucocele.

The incidence of mucocele of the appendix given by different authors varies from  $\frac{2}{10}$  to  $\frac{3}{10}$  of 1 per cent. It is generally agreed upon that pseudomyxoma peritonei of appendiceal origin is rare. The etiology is unknown. Acute attacks of appendicitis may be followed by proximal occlusion of the lumen of the appendix. The production of mucus may increase and cause a cystic swelling. There may be herniation of the mucous membrane through the muscular coat, producing diverticula of the appendix. These may rupture and the mucoid contents may be spread by intestinal peristalsis and grafted upon the serous surfaces of the peritoneal cavity. Morgan states that 50 per cent of the patients who come to surgery give a history of pain, discomfort or other variable symptoms referable to the right lower quadrant. In advanced

cases a mass might be felt, as in the case to be reported. In this case, a roentgenogram with contrast enema showed incomplete filling of the cecum, (Fig. 1.) LeWald<sup>7</sup> may have been the first to interpret this defect accurately, having made the diagnosis by x-ray, which was confirmed at operation. The patient in this unreported case was operated upon by Lyle<sup>8</sup> at St. Luke's Hospital, New York City, and was presented before the Surgical Section of the New York Academy of Medicine twenty-four years ago.

The treatment is surgical, consisting of removal of the appendix and mucocele and all secondary implants, if possible. I do not believe that the value of x-ray therapy, which is occasionally recommended, has been definitely established in this condition. Jackson<sup>9</sup> states that the removal of a mucocele appendix may possibly stop the spread of pseudomyxoma implants in the peritoneum. He likens it to the occasional case following the removal of a mother ovarian pseudomucinous cyst with spontaneous subsidence of secondary implants after removing the primary tumor.

## CASE REPORT

H. H. S., a male, age forty-six, was admitted to the First Surgical Division of St. Vincent's Hospital on September 30, 1940. He stated that six days before admission he had generalized abdominal pain with occasional localization of pain in his right lower quadrant. There was no nausea or vomiting. A similar episode had occurred eight months before which had lasted ten days. His white blood count was 13,100 with 55 per cent polymorphonuclears. He was observed for four days. He then signed

\* From the First Surgical Division, St. Vincent's Hospital. Presented before the Section of Surgery, New York Academy of Medicine, November 7, 1941.



an inflammatory process. There was no evidence of malignancy.

#### COMMENT

Considerable experience has been gained to evaluate the present treatment of megacolon. The progressive congenital neurogenic type can be improved with lumbar sympathectomy in the absence of gross pathological defects of the colon. These defects are not infrequently an accompaniment of these lesions and must always be determined prior to undertaking any form of therapy.

The use of drug therapy is temporarily beneficial and is an aid in determining the type of lesion. The toxicity of most cholinergic drugs prohibit using them over a long period of time. If there is a failure of improvement after the administration of acetylcholine, prostigmin and similar drugs, or following the administration of spinal anesthesia, it is evident that some gross lesion is present and must be corrected. It is possible for a gross pathologic process to be associated with an imbalance of the autonomic nervous system.

If there is failure of response to a nerve bloc, an exploration perhaps should be undertaken. The elongation and enlargement of the colon will allow the production of a volvulus. The sigmoid colon is the most frequent site of volvulus, due to its normal mobility. However, all segments can assume such an obstruction and cause serious consequences. Due to the multiple blood supply of the colon, volvulus does not cause gangrene as frequently as it would in the small intestine. However, if the rotation is complete and associated with an infection, it may produce a segmental necrosis.

#### SUMMARY

1. A review of the physiology and pathological anatomy of megacolon is presented.

2. The methods of classification and diagnosis of the condition is outlined.

3. The medical and surgical treatment is summarized.

4. A case is reported in which the patient developed an acute volvulus, necessitating resection of the transverse colon.

5. The etiological factor was shown to be an inflammatory constriction of the descending colon. This was corrected by the resection of the remainder of the colon. A successful anastomosis of the terminal ileum to the terminal colon was performed.

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the appendix but connected with its tip was an ovoid tumor 2.5 cm. in diameter. Distal to this tumor mass there was another ovoid tumor, slightly larger than the former in size. This latter tumor was adherent on one side to the middle tumor, and on the other side it was attached and incorporated in the wall of the large intestine at the rectosigmoidal level. The masses were seen to contain a mucoid material. The mucocoele appendix, the pelvic parietal peritoneal and the rectosigmoid implants were removed and a cholecystectomy was performed.

The pathological specimens were submitted to Dr. A. Rottino. He reported as follows:

Specimen (1) is an appendix, 6.5 cm. in length, having a moderately congested serosa. (Fig. 2.) On section, one finds a long sac within the meso-appendix filled with a glairy colorless, gelatin-like material. At one point a narrow tract connects this cavity with the lumen of the appendix. The wall is thick and the lumen small.

Specimen (3) is a small, irregular, red piece of tissue with adherent gelatinous material. Embedded in this material are numerous small white bodies.

*Microscopic: Appendix:* The wall of the appendix is diffusely infiltrated with eosinophils. The serosa is thick and fibrotic. (Fig. 3.) Very interestingly, the mucosa of the appendix continues into the cavity described above. Much of it, however, is ulcerated in the cavity. Here also the submucosal tissue in places is infiltrated with round cells and eosinophils. Its wall consists entirely of fibrous tissue. No muscularis is present. In the serosa is a very much thickened blood vessel.

The third specimen consists of fibromuscular tissue containing irregular cavities filled with mucin. (Fig. 4.) There is no evidence of colloid carcinoma. This latter mass suggests pseudomyxoma peritonei. Diagnosis: (1) chronic cholecystitis and lithiasis; (2) chronic appendicitis, diverticulum, mucocoele; (3) pseudomyxoma peritonei.

After operation the patient developed a postoperative pneumonia which responded satisfactorily to chemotherapy. Otherwise, his convalescence was satisfactory and he was discharged on his seventeenth postoperative day. He was last seen by me on October 16, 1941. He had regained his lost weight. Exami-

nation of his abdomen revealed a well healed wound. No masses could be felt. Digital rectal examination revealed no evidence of recurrence.

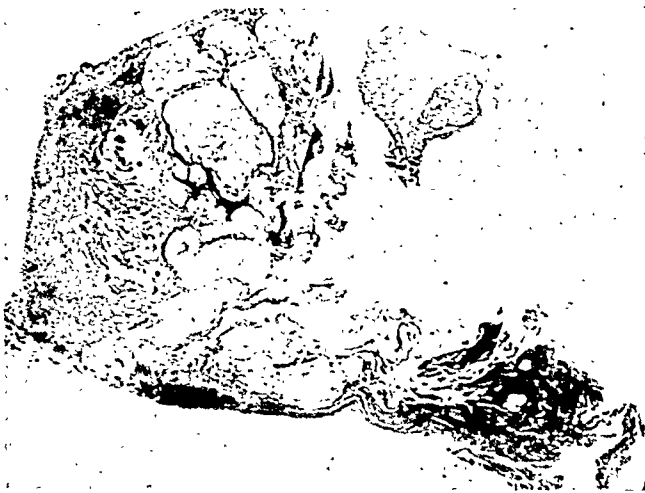


FIG. 4. Pseudomyxoma implant on rectosigmoid; microscopic section;  $\times 3$ .

#### CONCLUSION

1. Ruptured mucocoele of the appendix is of infrequent occurrence.
2. Effort should be made to remove the mucocoele and its implants, if at all possible. This is important because of its local invasive tendencies.
3. Through the fortunate circumstances of only local spread, a case of removal of a ruptured mucocoele with its implants is hereby recorded.

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a release and went home. The diagnosis was chronic recurrent appendicitis. He again entered the hospital on February 10, 1941. His chief

diagnosis was: (1) chronic cholecystitis with cholelithiasis; (2) chronic appendicitis; (3) possible malignancy of the cecum.



FIG. 1. Roentgenogram with contrast enema, showing incomplete filling of cecum. Gallstone showing above hepatic flexure of colon.

complaint was dull constant pain in the abdomen of two months' duration. He also noticed bright red rectal bleeding. His weight loss was twenty-five pounds in the past six months. His past history seemed to bear no relationship to his present complaint. His systemic review was essentially negative. Physical examination showed that he was markedly underweight. He appeared to be chronically ill. Examination of his abdomen revealed a small, firm, palpable mass in the right lower quadrant, 5 cm. medial to the right anterior iliac spine. Proctoscopic examination revealed a prolapsed, ulcerated internal hemorrhoid. The sigmoidoscope was passed for 25 cm. This revealed no discernible cause for bleeding other than internal hemorrhoids. X-ray studies of his gastrointestinal tract and gallbladder were made. The most important findings were, one gallstone, no visualization of the appendix, and a slight deformity of the cecum. It could not be determined whether this deformity of the cecum was inflammatory or neoplastic. The routine laboratory tests were performed. These were within normal limits. The tentative

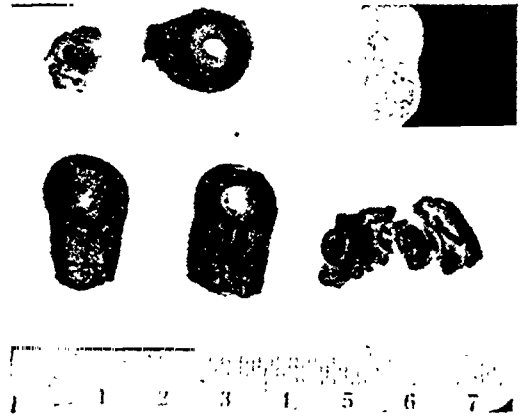


FIG. 2. Gross sections of thickened mucocele appendix with mucus filled cavities in both appendix and meso-appendix.



FIG. 3. Appendix; microscopic section.  $\times 4$ .

Operation was performed on February 25, 1941, under cyclopropane ether anesthesia. The operative findings consisted of a gray, thickened, and somewhat enlarged gallbladder containing a solitary stone, and a thick appendix of firm consistency, 6.5 cm. in length and 3.0 cm. in diameter. It was densely adherent and closely attached to the parietal pelvic peritoneum. The induration of the appendix extended to the wall of the cecum. Distal to

robot the power of speech and thinking. Then the story was told that Thomas Aquinas, his famous and illustrious pupil, shattered the work because he considered it an agent of the devil.

Another story built out of superstition was that on one occasion in the dead of winter, with the ground covered with snow, William, the Roman Emperor, was passing through Cologne and sought shelter in the Dominican cloister where Albertus lived. The country through which the king had just passed en route was inanimate and silent as one would expect in deep winter, but it was his profound astonishment and amazement to find Albertus in a beautiful garden filled with plants and shrubs, some of these in full bloom and with some of the trees bearing fruit. The air was filled with a fragrance of blossoms. Here, in the center of the garden, a sumptuous banquet was served to the king. As soon, however, as the royal cortège had left the neighborhood, all these things disappeared and there was again only the silence of winter. So, of course, Albertus must be a magician who had produced all this out of thin air in order to impress the travelling monarch favorably.

A more materialistic explanation of the same episode would have been that Albertus, being one of the foremost botanists of the world, had probably one of the largest conservatories in all of Europe in the gardens of the monastery. Thus could easily be explained the summer temperature in the midst of winter, and also the blooming shrubs and blossoms. Such a simple event easily explained by rational reasoning can take on an entirely different interpretation when one seeks the marvelous or miraculous and is superstitiously inclined.

One cannot find, however, a single word in all of his writings nor in any of the accounts of his life which would justify calling him a magician.

Without a doubt, in spite of his great fund of knowledge and his genius, Albertus was a victim, along with his scientific con-

temporaries, of the errors of his time. However, one should not judge men of science of those times by the errors which they committed, but should think only of the exact facts which they added to the fund of knowledge which already existed.

Albertus' greatest literary effort was the "Opera Omnis" which consisted of twenty-one volumes. It has been said in criticism that it would have been physically impossible for one human being to have produced such a huge amount of original work in spite of the fact that Albertus was known as a prodigious worker. It must be kept in mind that his manuscripts were not translated and arranged for printing until 400 years after their creation and that much was undoubtedly added by others not quite so competent. Therefore, many errors cannot be legitimately attributed to his authorship. When one gazes at the vast number of works attributed to Albertus, one cannot help but think that possibly the criticism and questioning of authorship may be just. How could one individual compile so much, considering the amount of research necessary for such a work and the time consumed in the collection and compilation of the material before the manuscript could ever have been written? There is, obviously, ample ground for doubt.

Perhaps an explanation might be that the bulk of his work was done by collaborators and students under his direction, with the finished product carrying only his name.

Albertus was born in the year 1193. His family name was Bollstadt, borne at the time by a very rich and powerful family in Germany. To have been born rich was fortunate in his particular case because he was able to command the necessary funds for his extensive travels within and without his own country in later years, and to accumulate the large collection of specimens, etc. which he needed in his studies.

It has been said that in his early youth his intelligence was poor and his learning very slow. As a young man, however, his knowledge and intelligence astounded all of

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ALBERTUS MAGNUS (1193-1265)

INCUNABULA MEDICA VII

FELIX CUNHA, M.D.

SAN FRANCISCO, CALIFORNIA

THE name Albertus Magnus, "Albert the Great," or Albert von Bollstadt, is that of one of the three most celebrated and famous thinkers of the Middle Ages. In the large number of scientific manuscripts, treatises on philosophy, medicine, etc., which appeared during the thirteenth and fourteenth centuries, there is hardly one in which mention is not made of Albertus Magnus. The degree to which he influenced later years can be judged in a way by the fact that even to this very day the religious peasantry of Europe know and have heard of the name of Albert the Great, but usually he is known to them in the rôle of an astrologer or magician.

It is not difficult to understand this conception, since in the era in which he lived, people were still in a more or less semi-barbarous state. Cabalistic signs and magic were a part of the prevalent ideas explaining common everyday phenomena, and superstition was imbedded in every act of daily life and practice. All classes of people, the nobility, the clergy, the scientists, as well as the poor and the ignorant, believed in magic. Although severe and strict laws were leveled at sorcerers and at anyone accused of having dealings with sorcerers, witchcraft was a problem for several additional centuries beyond the thirteenth, as history shows.

The people were accustomed to seeing the priests seriously engaged in contemplating the sky and charting the course of the stars. According to their own particular mood and belief they were apt to either accuse the studious one of being a sorcerer

or credit him with being a true astrologer who studied the influence of the stars on human conduct.

If a man occupied himself with natural history, or if he had chemical and physical laboratory paraphernalia, or were out in the country or woods engaged in collecting plants or minerals, he was either credited with being an alchemist engaged in the transmutation of metals or condemned as a magician in league with the devil.

The laity had another reason for thinking always of Albertus as a magician because the painters of the Middle Ages represented him in their works always as an alchemist or an astrologer, consulting the stars or working with an alembic. Usually they painted him standing or sitting near a table on which were many types of minerals, books, manuscripts, etc. Other artists depicted him in a church pew, deeply absorbed in prayer or meditation, but always present in the same minor detail was the background of alchemy or astrology. He was always made to appear as a pale thin individual of small stature, but actually his entire physiognomy denoted a strong will and utmost perseverance.

Strange miracles were attributed to him and many stories were related to tell of these. One was that he had constructed a human head which was able to speak. This came about from the fact that he had built or had attempted to build a "mechanical being" but it was constructed of iron, perhaps the first attempt at constructing our modern robot. But the laity, in their superstition and ignorance, attributed to this

despair from which I have lifted you." And with that the vision disappeared.

It is not impossible that Albertus in his

plished. Albertus immediately began to astonish his teachers and superiors by his comprehensive knowledge and later be-

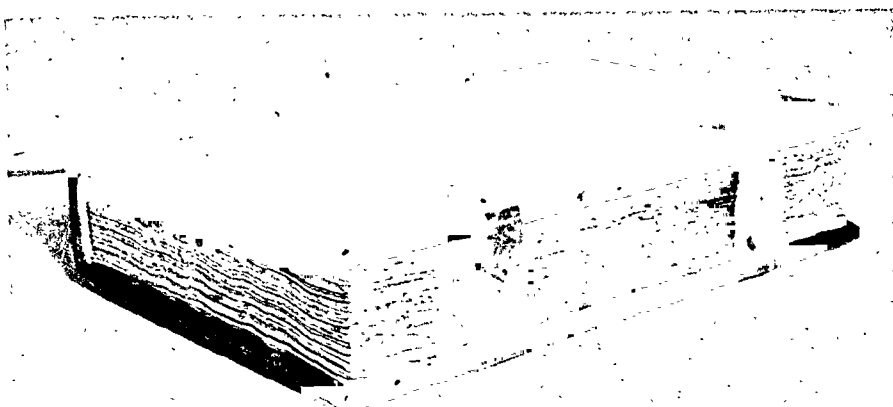


FIG. 2.

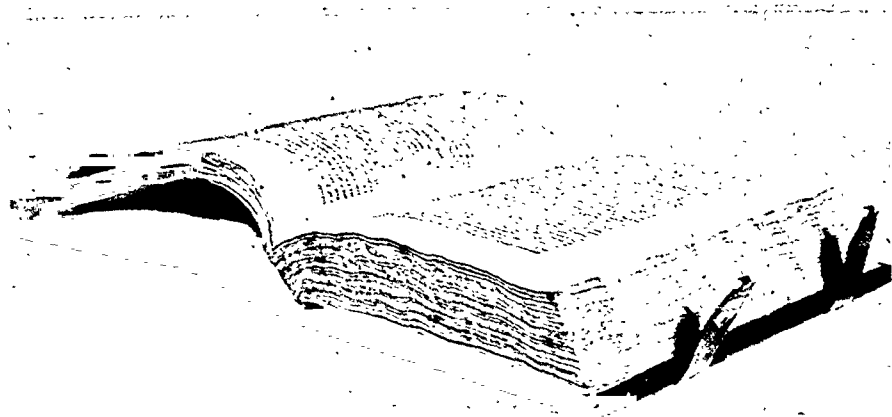


FIG. 3.

FIG. 2. A copy of "Sermones de Tempore" by Albertus Magnus. Printed by Johann Wiener in Augsburg in 1476. This illustrates a magnificent specimen of leather bookbinding of the period and 350 years later in an excellent state of preservation.

FIG. 3. The same as Figure 2 showing the book open. This is illustrative of the highest attainment of the art of printing at that time.

youth, his entire spirit being imbued with the passion for study and with deep religious fervor, possessed also by a deep desire to make a place for himself in the world of science amid the celebrities of his time, might not have had a dream such as described above and related it to some of his associates. As the origin of the story is attributed to Fra Bartolomei, his confessor and superior in the Dominican Order, it might serve as a simple explanation for such a superstition. Prophetic dreams are not rare in the lives of great men or men of genius.

Be that as it may, the first part of the prediction was not late in being accom-

plished. Albertus immediately began to astonish his teachers and superiors by his comprehensive knowledge and later became one of the most celebrated men of science of his century. It is related that the second part of the superstitious legend also came to pass. At the age of 80, just three years prior to his death, he was seated in his chair in Cologne giving a lecture to his students when suddenly he became speechless and fell over on his side as if struck by some object. From that time on he was confined to bed, his mental faculties lost, and continued speechless. Of course, if one wishes to take away the superstition from this story, one more materially minded would say that Albertus had suffered a cerebral hemorrhage to which he could most certainly be susceptible at the age of

his teachers. It is amusing to read in the biographies of Albertus Magnus, Thomas Aquinas and Duns Scotus, three of the all efforts at serious study, the Holy Virgin, touched by his piety, appeared before him in all of her glory, to arouse him from the



ALBERTUS MAGNUS.

*From a rare print*

FIG. 1. A scarce print of Albertus Magnus.

greatest minds of the thirteenth century that they were accused of stupidity and a colossal lack of intelligence in their early studies. Thomas Aquinas was called "The Dumb Ox" and our present day word "dunce" owes its derivation way back in time to a "transposition" of Scotus' first name "Duns."

With reference to Albertus' youth and studies, another superstition exists: It is told that on one occasion when he was very melancholic and in deep despair, considering whether or not the wisest move for him was to renounce the religious cloister and

depths of despair into which he had plunged.

"In which branch of science," said the apparition, "Would you prefer to excel—theology or philosophy?" Albertus chose without hesitation, philosophy. At the same instant, so the story goes, the Virgin endowed him with the gift of genius, replying, "You shall be one of the most distinguished men of science. But as you have preferred the profane theories of materialism in place of the beauty of divine science, in punishment for your choice you will one day return to that same stupidity and

which were considered lost. He copied, translated and had them arranged by some of his junior assistants in the order who often accompanied him and helped him in his researches. In this manner he collected the vast amount of material he used in many of his later books.

The effect of getting off into lonely isolated pathways and highways must have been an inspiration to a man possessed of a vivid imagination and a speculative mind. To the great philosophic minds of history solitude has been the necessary adjunct of contemplative thinking. To see nature at different times of the day, different seasons of the year and its effect on all living things, the elements under different conditions, etc., could not help but stir such an individual to deep thought as to the why therefor. It was probably of incalculable value in helping him to evaluate between positive science and theology and thus be able to expound it so clearly. He was the first of the philosophers to demonstrate that the one could be accepted without refutation of the other. This, of course, made him even more popular, so that from all countries scholars came to Cologne to attend his lectures. In view of the fact that the Church was distinctly against the tenets of positive science, this was no small labor.

In 1245 the head of the Dominican order decided that Albertus should be sent to Paris in order to receive his diploma as Master of Science. Only the University of Paris was empowered to confer this degree, and it was necessary to attend the courses for three years before it could be obtained. Here the true measure of one's intellectual ability was severely tested because the teaching usually consisted of open debate before a large and distinguished audience of scholars and men of science. The University of Paris during the time of Albertus was considered the most brilliant scholastic faculty, and its instructors were equally brilliant and renowned.

There was at this time at the University of Paris considerable discord, particularly

among the faculty. Up to about 1200 there had been only two divisions in the University, professors who taught, and students who learned. However, a few priests had been admitted to the teaching faculty by royal decree. They were unable to adapt themselves to the general scheme of things because of their individual fixed ideas, and the faculty was therefore kept in a constant state of embroilment. The result was that there was a division of faculty and students according to belief, into three distinct groups, one a school of theology which was dominated by the fathers, the other a school of laws, dominated by the group most interested in law, and a third group constituting a school of medicine. This inability on the part of the fathers to adapt themselves to the general scheme of things as they existed led to the formation of the first real and distinctly separate medical school. It constituted the first time that a definite line of cleavage had been drawn between medicine and philosophy. From the standpoint of medicine as a science, and also from the standpoint of medical history, this was an event of utmost importance.

Paris at that time was almost entirely a city of students, principally because of the fame of its university. The students composed a collective body so much larger than the farm or laboring city class that they demanded extraordinary privileges for themselves, such as immunity to arrest unless for very grave crime, etc., on the threat of moving elsewhere. This, of course, would have meant ruin for every shopkeeper and workman in Paris. The extraordinary privileges were accordingly granted. The activity of pressure groups is therefore not a phenomenon restricted to the present day.

The church itself was also in a period of uncertainty because of the efforts of the intellectual minds to merge philosophy with theology. This became so troublesome that the church threatened with excommunication any and all who expounded or believed in the philosophy of Aristotle.



80. That would give the same clinical picture, i.e., toppling over from a "stroke."

On this occasion Albertus immediately recalled the dream of his youth and felt that the second part of the prophecy had come to pass, that the most important part of his life, his intelligence, had been taken from him. It gave rise to a saying among the elders, "Albert the Great, who was changed from an ass into a philosopher, was afterward changed from a philosopher into an ass."

To return, however, to his life as a student. Having demonstrated his capacity to absorb knowledge, he was sent to visit the principal schools in the centers of learning of Germany, Italy, and France. It was in Padua that he seriously commenced the study of philosophy, medicine and mathematics. In that city he became associated with the superior general of the Dominican order, Father Jordan, a most learned and influential man. This association had considerable influence upon his future destiny.

It was the custom and practice of the Dominican fathers to recruit to their ranks the sons of families of prominence and fortune who gave promise of intellectual attainment. Albertus, of course, had all of the necessary qualifications, birth, fortune, family, character, intelligence and imagination. It was only natural therefore that through the influence of Father Jordan he should become a member of the Dominican order.

During the Middle Ages, Europe was a hotbed of civil and state wars, and the people in general were in a constant state of oppression either from one captor or another, so that for one who was studiously inclined life in a monastery had its compensations. It was quite, free from outside intervention and held by all warring factions to be inviolate. It is supposed by his biographers that he entered the Dominican order either in 1222 or 1223, the exact date being uncertain.

Following the completion of his studies at Padua, Albertus was sent to Cologne in Germany, where the principal school of the

Dominican order was located. Those who were selected for this school were expected to show exceptional capability and to take their places later among the leading orators and teachers of the day. This was not an easy task as the difficulties to be overcome in attaining to this rank were considerable. It was necessary that one should above all be of superior intelligence, a true lover and student of science, with a desire to communicate this to others by teaching, a strong character and above everything in absolute obedience to the strict discipline of the order. These qualities were, of course, all present in Albert von Bollstadt.

Albertus began his career in Cologne as a lecturer in natural science and religious science, the two subjects which were most in the minds of all students of the century. His lectures were extraordinarily successful. There had never been in the order anyone who so ably interpreted and expounded the theological and scientific dogmas of the day with such clarity and force.

It was to the best interests of the Dominicans, and for the purpose of furthering the prestige of the order, that Albertus should deliver these same lectures in the great centers of population. So he was then sent to such large university seats of learning as Fribourg, Ratisbone, and Hildesheim. In all of these and others he was preceded by a fame which was mounting each day. These lecture tours were a grand succession of triumphs for Albertus. By the end of the year 1240, having completed his "Grand Tour" as it was designated he was recalled to Cologne.

During all the while that he made these lecture tours, however, he was constantly adding to his fund of knowledge by study. Travel in his day was on foot, but instead of taking the more well known roads, he took the little known byways which gave him an opportunity to pick up specimens, stones, plants, roots, shrubs, etc. At the same time he visited all of the libraries in the convents and monasteries along his route, collecting literary material. In this manner he discovered many old hidden manuscripts

name, named him Bishop of Ratisbone. This post carried with it the highest degree of social prestige and dignity and was a position of real authority. He became extremely popular in his rich diocese because of his simplicity and his endless charity, but he was unhappy and much preferred his simple cell in the monastery in Cologne to the magnificent palace in which he lived as Bishop of Ratisbone. His unhappiness increased to the point where at the end of three years he asked to be relieved of his duties and to relinquish his title as a Prince of the Church. This was granted and he returned to Cologne, where he was again happy to be a simple monk and to have the opportunity of study.

The life of a monk and of study was to be short-lived as word had been spread throughout Europe of the persecution and horrible massacre of countless Christians in Asia. Albertus received orders from the Pope, Clement IV, to conduct a preaching crusade throughout Germany and Bohemia in behalf of Christianity.

Having accomplished this mission, he again returned to Cologne, but was almost immediately ordered away again, this time to take part in the celebrated Council of Lyons. On this mission he departed in a much happier frame of mind, inasmuch as he hoped to meet at this Council his friend and former pupil Thomas Aquinas. This was not to take place, as the Angelic Doctor died on the way to the conference in a small, out of the way abbey in France. Thomas' death caused him profound grief and grave disappointment, and it was noted at the conference that his enthusiasm and energies were much dampened.

After the conference, Albertus returned to Cologne and took up his lecturing again, but a short time afterward he was stricken with apoplexy and was never again able to appear before his students. His mind became completely a blank. He was able only to visit every day the plot he selected for his grave. He lived for three years after his stroke, unable to think, unable to speak, life a complete blank.

Having briefly described his life which as one can see was completely and fully occupied up to his mental and intellectual death, how can one account for the completion of twenty-one immense volumes of research transcribed laboriously on parchment, in addition to the voluminous amount of other work which is attributed to him.

To anyone who has any conception of the amount of labor involved in assembling the necessary material for a scientific or historical work, say for example an octavo edition of 700-800 pages, it can readily be seen that one man alone could not possibly have written twenty-one such volumes as those of Albertus Magnus, even if he had spent his entire lifetime only in writing. Then when one considers the time he consumed in lecturing, in preparing these lectures, in traveling, in directing his province as Provincial, later his diocese as Bishop, it can be seen that it was not humanly possible for him to have accomplished such an opus alone. Therefore a great many of the works attributed to him were probably the work of assistants or collaborators, but he was, possibly, the guiding or directing genius.

A French scientist, Pouchet, has written an entire book to show that all of the science of the Middle Ages began with Albert the Great. A science, however, cannot be conceived as the work of one man. It consists of the piling up of a series of observations, based upon experiments; although one man may contribute much, it can never be said that he contributes all.

Perhaps Albertus' one outstanding contribution to the world was his work in bringing together the theology of the church and natural science. This he did by demonstrating the greatness and the power of a supreme artist, a supreme scientist, as manifested by the everyday observations of nature around us.

It is true perhaps that many of the doctrines and theories he expounded had existed prior to him, that he had found them in the manuscripts hidden in the old

It was in the heat of this ecclesiastical and intellectual turmoil that Albertus arrived in Paris, accompanied by his pupil and friend Thomas Aquinas, the Thomas Aquinas who was to be the beacon light of learning of the thirteenth century.

Albertus was immediately successful in everything he did. His system of discussing, reasoning and solving problems made such an instantaneous success that students came to Paris from every part of Europe. The university halls were not large enough to accommodate them and it was necessary for Albertus to conduct his classes in the open air, in a public square adjacent to the University. This acquired the name "Place de Maître Albert" or Place Menbert in more recent times. There still exists on the wall of an old building in which there is today a pharmacy, parts of a fresco showing Albertus surrounded by his students, all in the costumes of the Middle Ages, listening to the Master.

The foundation of Albertus' lectures was the science of the earliest Greek times as typified by the manuscripts preserved by Aristotle for the generations to follow and made available through his own writings. The lectures consisted of a collection of observed facts, studied and coördinated according to the reasoning and scientific investigation of the Greek minds of Aristotle's time, made to fit the needs of the Middle Ages and its intellectuals by Albertus.

It had been difficult therefore to separate true scientific thought from the highly speculative metaphysical. Albertus, however, did this so well that the minds of his pupils were hypnotized by his imagination, his ideas and his knowledge. They did not wish to hear any other lecturer, but waited breathlessly for the last word in science from this Dominican who had so fired their imagination. He was regarded almost as a supreme being from whom no secret of earth or sky was hidden.

Two of his pupils at these lectures were later to carry on and become as famous as the Master himself, Roger Bacon and

Thomas Aquinas. Another name which was to become most famous in the field of chemistry and medicine later, was Arnold of Villanova, also a pupil at this time.

In 1248 Albertus was recalled to Cologne and left Paris once again, accompanied by his pupil, Thomas Aquinas. At Cologne he was named Regent of the Dominican College.

From then on, the path of students of science and philosophy from all of the then known world led to Cologne, so that the "Master" was again compelled to lecture in an open square to accommodate the large number of students who came to hear him.

In 1254, during a conclave at Worms in Germany, Albertus was raised to the ultra-dignified status of a Provincial in the order. This meant that he was in charge of the administration of one province of the Dominican order, consisting of Austria, Bavaria, Saxony, Alsace and Holland.

Albertus began to comply with the duties involved by visiting on foot the entire province in his charge. Since he was extremely simple in his needs and in everything he did, it was perhaps difficult to reconcile such a modest, unassuming appearing person with the great mind known throughout all Europe. But as proof of his sincerity in his beliefs and mission in life, neither honors from the Pope himself, nor from great kings or princes could persuade him to leave Cologne for some other city, other than for a temporary visit.

He journeyed to Rome for the purpose of conducting some important theological conferences under the patronage of Pope Alexander IV, but did not remain long and returned again to Cologne. In 1255 he once more visited Rome, this time accompanied by his pupil, Thomas Aquinas, in order to defend before the Pope certain privileges which were held by the Dominicans and which were in danger of being taken away.

In 1259 he resigned his office as Provincial in the order that he might have more time for study, but the Pope, not wishing to lose from the Church such a glorious

is devoted to an explanation of thermal springs, of the hot waters present in them, and of their use in the treatment of disease.

He observes that he believes that in the time of Aristotle an instrument was known which would guide ships over the seas, in the manner of our modern compass. However, there exists authority that the Phoenicians long before the Christian era used an instrument of navigation and prior to them the Chinese also used such an instrument.

His "De Coele et Mundo" and his "De Generatione et Corruptione" came after the work in physics, then the book on "Meteores" and then "De Mineralibus." The work on minerals is believed to be entirely the elaboration of his own original observations. He describes in alphabetical order all the minerals which he knew. Nothing is described of which he did not have actual personal knowledge.

His book, "De Animalibus" is considered his best work, most scholarly and the most instructive. Authorities claim that they can see in the style of writing and the arrangement of facts large borrowings from the writings of Aristotle; they state, in fact, that it is merely a copying of Aristotle's work with some additions and commentaries of his own. Others claim that in the section devoted to "Anatomy" he completely changes the descriptions of Aristotle, and that his description is more intelligible, more complete and more remarkable. In this he followed a new plan of his own and a definite order. First he described the vertebral column, then the thorax, then a complete osteology with a careful minute description of the bones. Next in order he described muscles in general, then more minutely the muscles of the head, then next a description of the anatomy of the nervous system, with a detailed description of the cranial nerves, and a description of their origin and distribution.

Then follows a description of the circulatory system which is supposed to be more detailed and even more complete than that of Aristotle.

The work ends with a description of the phenomena of generation in animals and by almost a word for word translation of the physiology of Aristotle.

There are then six works devoted to "Physiognomy" similar to that of Aristotle, plus additions from the work of Theophrastus on "character." It seems that Albertus was the first to call attention to the idea of determining certain human characteristics by an examination of the protuberances of the skull, the earliest mention of the science of phrenology.

It is felt by many close students of his writings that wherever he deviates from the writing of Aristotle, he falls into the style of the old Arabian men of science, to whose manuscripts he had access.

His twenty-first volume is an endeavor to assign to man his relative place in the general scheme of things as related to other things around him. This constituted the correlation of natural science with theology.

His twenty-second volume is a natural history of all the animals known in Europe, a zoölogy. In this work he was able to add to the knowledge gained by Aristotle and Pliny in that he described animals of the polar region, of which they had no way of gaining knowledge. He also described whales and the methods used in their capture, which was entirely new, never mentioned before. Whether Albertus ever journeyed to the polar region is debatable. He may have traveled sufficiently far north on the coast to have acquired personal knowledge of all this, or perhaps he obtained information from native inhabitants.

His twenty-third volume was devoted to birds, describing in detail all species known to him, their habits, diseases, method of treatment, etc. Also a large section devoted to falconry, methods of training falcons, etc.

His twenty-fourth volume is devoted to animals living in the sea, the twenty-fifth to serpents and reptiles, then the "De Parvis Animalibus Sanguinem non Habentibus" of "small animals which have no blood," insects, and like.

monasteries and libraries which he visited. Many ideas were not original with him, but merely translations from the Greek. After all, however, it was his diligence in uncovering them which made them available for future generations—and for that we owe him a profound debt of gratitude.

It is also felt that much of what he gathered, translated, and compiled still exists today, unknown to present day scholars, in the great Spanish, Egyptian and Turkish libraries. Some day perhaps it also will be brought to light and then the genius of the man will be even more fully understood.

It was not difficult, of course, for him to uncover a vast amount of material, because his social position and his powerful position in the Dominican order gave him access to the libraries of a large number of monasteries, to the great collection of manuscripts in these monasteries, and also to the enormous collections of the Popes.

As an illustration, not long ago in Bohemia, there was unearthed a library of manuscripts that had not seen the light of day, according to authoritative estimation, for more than five hundred years. It was the buried underground crypt of a monastery, where scribes probably worked, and among these manuscripts were several attributed to Albertus.

There were also hundreds of the humbler members of his order whom he could call upon as assistants to translate these manuscripts from the original Arabic, Greek or Oriental languages and to classify and catalog the acquired documents.

It has often been stated by his critics that none of his works was original with himself, that for everything which he wrote or which was credited to his authorship, an original manuscript can be checked in some ancient library. He merely had access to the manuscript, assigned a monk to translate it, then passed it on as his own. Much of his medical work, particularly his vast encyclopedia, consists merely of recapitulating the work of Avicenna, who had translated into the Arabian the works

of Galen and Aristotle. Albertus translated it, or more probably had it translated, into Latin, and it then appeared as his work. Avicenna had added some commentaries of his own and Albert also added here and there a notation of his own. The works of Avicenna were, of course, the scientific authority on natural history, physics, chemistry and medicine during the Middle Ages and were the basic work used at the great schools of medicine in Europe, that of Salerno and also that of Montpellier.

It is assumed that these collaborators with Albertus had access to a large number of Arabian manuscripts, such as those of Rhazes, a contemporary of Avicenna and also those of Averroes and many others of less renown.

His twenty-one huge volumes or "Opera Magna" can, therefore, be considered not as an original work, but as a résumé of all that his satellites had collected and translated. This material was used by him over a period of forty years or more in lectures in various centers of learning, then gathered together under his editorship, as in the modern manner.

It is curious also to the bibliophile that the arrangement of his work follows almost step by step that of Aristotle, although it is definitely known that Albertus did not use the Greek text of Aristotle but rather the Arabian of Avicenna. Aristotle devotes his first eight books to physics, and so in like manner does Albertus.

He treats in these eight books of the study of natural forces, the earth and sky, the laws of generation of living things, and of the phenomena accompanying death with decomposition of the body. One of these books, however, "De Natura Vorum" differs widely from Aristotle according to authorities. The views therein are his own original observations. It is here he first represents the earth as round, 250 years before Columbus became obsessed with the idea.

He also devotes an entire chapter (which is his own original work) in an explanation of the origin of meteors. Another chapter

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A botanical treatise, "*De Vegetabilibus et Plantis*," although of only 160 manuscript pages, is considered a monumental work, because his own observation was so keen and critical and he described the anatomy and physiology of plants so thoroughly that to the present day little change has been made in the description of those specimens to which he had access.

All of these writings were part of a definite plan; this encyclopedia of knowledge, embracing all of the sciences of his day, was an idea born from the study of Aristotle. The idea was not merely to bring it up to date, but with Albertus there was an additional purpose, to throw light upon natural laws and the miracles of nature. His aim was to supply a basis for a theology and to show the relation between man and God. He was truly the Aristotle of the Middle Ages.

Albertus the Great was buried in a small church in Cologne, St. Andrew's, hidden away, with no monument and no epitaph, in simplicity such as that in which he had lived.

To list some of his contributions which are more or less undisputed by his critics one would name the following:

In his "*De Mineralibus*" he first hinted at the use of minerals in the treatment of disease. He first made use of the word "amalgam," a compound of mercury, although sometimes credit for this is given

to his pupil, Thomas Aquinas. He was the first to describe the magnet properties of lodestone and enumerated different metals having magnet properties with a full description of each.

In his "*Liber Cosmographicus de Natura Locorum*" he first called attention to the influence of latitude and longitude on temperature and the influence of the degree of angle of the sun rays in heating the ground.

In his "*De Coelo et Mundo*" he first described the Milky Way as being a vast collection of stars.

In his "*Physica*" he first described the power of refraction of certain crystals and mentions mirrors.

In his "*De Vegetabilibus et Plantis*" he described the sleep of plants, the periodical opening and closing of blossoms, the diminution of sap through evaporation from the cuticle of leaves and the influence of the distribution of the bundles of circulatory vessels on the folial indentations. At the end of this particular book he says: "All that is here written is the result of our own experience or has been borrowed from authors whom we know to have written only what their personal experience has confirmed, for in such matters only experience can give certainty."

To Albertus Magnus, therefore, is medical science indeed indebted.



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